2009NARST

Annual International Conference

Grand Challenges and Great Opportunities in Science Education

April 17 – April 21, 2009

Hyatt Regency Orange County
Garden Grove, CA

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Acknowledgments

The following members of the Program Committee helped in preparing and editing the 2009 NARST Annual International Conference Program Book.

Charlene M. Czerniak, President and Program Committee Chair
Richard A. Duschl, President-Elect
William C. Kyle, Jr., Executive Director
Toni Sondergeld, NARST Graduate Student, The University of Toledo

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Floor Plan

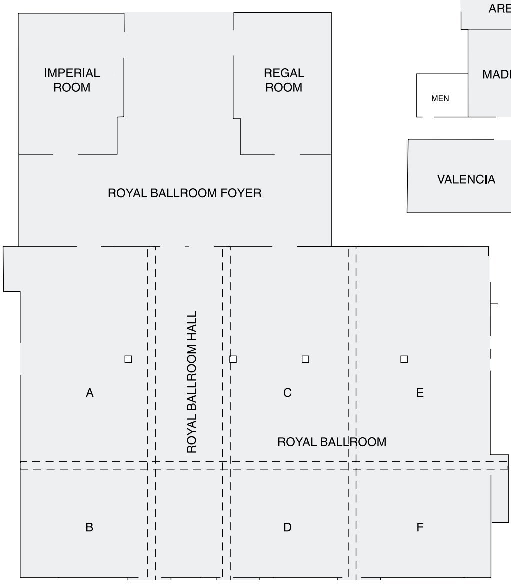
Hyatt Regency Orange County

DIRECTIONS

From Los Angeles Int'l Airport: Take Hwy. 105 East to 405 South to 22 Fwy. East. Exit at Harbor Blvd. North. Turn right onto Harbor. Hotel is 2 miles on left.

From Orange County / John Wayne Airport: Take 55 Fwy. North to 5 Fwy. North to Chapman Ave. Exit and turn left. Hotel is 2 miles on right.

FIRST FLOOR (SOUTH TOWER)



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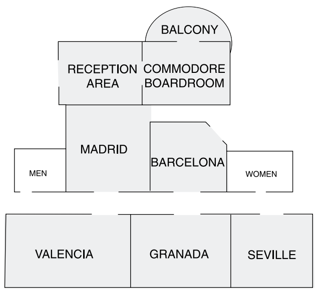

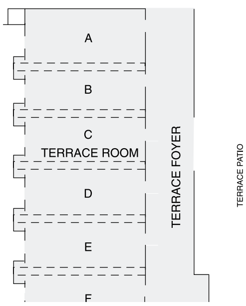

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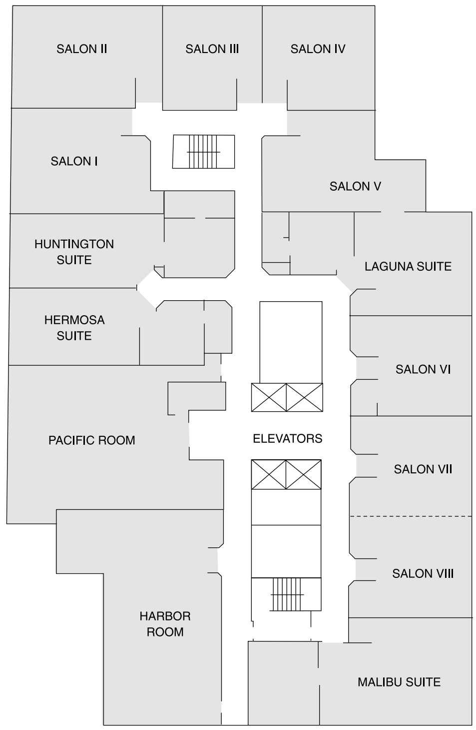
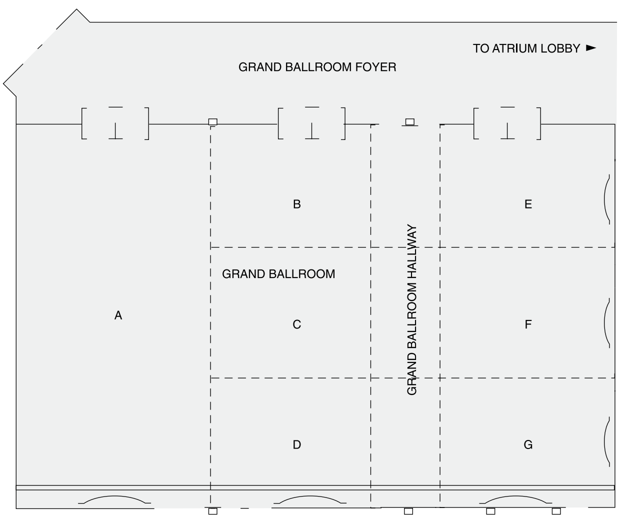


GRAND BALLROOM



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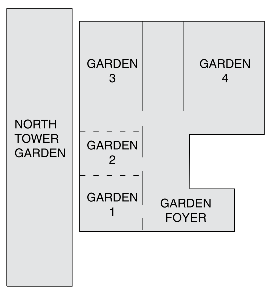

General Information

Information about NARST

The National Association for Research in Science Teaching was founded in 1928 for the purpose of promoting research in science education at all educational levels and disseminating the findings of this research in such ways as to improve science teaching and learning. The Association is incorporated as a non-profit corporation in the State of Minnesota. The official publication is the Journal of Research in Science Teaching.

NARST encourages presentations of a wide variety of investigations in all aspects of science education, including action, historical, philosophical, ethnographic, experimental, and evaluative research studies. Reports of empirical research, critical reviews, and theoretical works are encouraged. Research areas of interest to NARST members include curriculum development and organization, assessment and evaluation, learning theory, teacher education, programs for exceptional students (special needs and talents), equity studies, policy, and methods of teaching.

NARST Mission Statement

The National Association for Research in Science Teaching (NARST) is a worldwide organization of professionals committed to the improvement of science teaching and learning through research. Since its inception in 1928, NARST has promoted research in science education and the communication of knowledge generated by the research. The ultimate goal of NARST is to help all learners achieve science literacy. NARST promotes this goal by: 1) encouraging and supporting the application of diverse research methods and theoretical perspectives from multiple disciplines to the investigation of teaching and learning in science; 2) communicating science education research findings to researchers, practitioners, and policy makers; and 3) cooperating with other educational and scientific societies to influence educational policies. To learn more about NARST you may visit the Association's website at http://narst.org/ and read the Bylaws approved by the membership in October 2008 at http://www.narst.org/about/NARST_bylaws.pdf.

How NARST Keeps Its Members Informed

• Ten issues of the Journal of Research in Science Teaching (JRST) are published each volume year. The Journal has been ranked as one of the highest quality educational journals according to studies published by War, Holland and Schramm (American Educational Research Journal) and Guba and Clark (Educational Researcher) for the American Educational Research Association (AERA). These authors identified JRST as clearly the top research journal in science education.

• NARST Annual International Conference Proceedings is distributed at the Annual International Conference. This volume includes a compiled list of abstracts (on CD-ROM) for the current Annual International Conference, plus copies of accepted papers submitted prior to the conference. Members attending the conference receive a copy on-site and the cost is included in their registration fee.

• E-NARST News describing recent developments in research and in the profession. E-NARST News provides opportunities to work with prominent people throughout the world on research projects and with affiliated organizations such as the National Science Teachers Association (NSTA), the Association for Science Teacher Education (ASTE), and the American Association for the Advancement of Science (AAAS). Our newsletter is now published online twice a year and posted to the NARST website.

• Website and Listserv, allowing access to further information about the Association. You may access this site at the following URL http://www.narst.org. There is further information about the Listserv on this site.

Explanation of Program Session Formats

Paper Sessions Organized by the Program Committee

In a paper session, the presider introduces the presenters and monitors the time used for each presentation. All papers will be allotted 15 minutes for presentation, followed by approximately 5 minutes of questions or discussion. The presider and audience will use any time remaining in the session for additional discussion, general review, and suggestions for further research. The overall length of the paper sessions may vary based on the number of papers assigned to that session, but each paper within a particular session will observe the 15-minute presentation guideline. For example, four papers grouped together will be given a 90-minute time period, while two papers grouped together will be given a 45-minute time period for the overall session. This will optimize the grouping of papers by allowing strand coordinators to group papers based on similarity, rather than forcing the grouping of papers to fit a standard time block. Each presenter is expected to disseminate a paper during or immediately following the session, unless the paper is on the NARST Proceedings 2009 CD, distributed as part of the program.

Symposium

A symposium involves a panel of experts or stakeholders who examines a specific theme or issue. This format does not involve the presentation of individual papers. Therefore, individual papers and authors will not be listed under this format. Rather, the participants are listed as panel members. The proposer controls presentations, discussion, and questioning with the assistance of the presider or discussant (if designated). Discussion should promote the expression of similar or alternative viewpoints and theoretical positions. The proposer of the symposium is expected to disseminate a paper or a summary with references during or immediately following the session, unless a summary of the symposium is on the NARST Proceedings 2009 CD.

Related Paper Set

This category accommodates, in a single session, three to five related research papers reporting several studies that originate from a common base of research. This format also allows for common elements of design or approach to be presented once rather than repetitively. The proposer and authors may determine the specifics of the session once it is accepted. For instance, those involved may opt for a formal presentation style or they may conduct their session in a more informal, discussion-oriented style. Each presenter is expected to disseminate a paper during or immediately following the session, unless a summary of the related paper set is on the NARST Proceedings 2009 CD.

Interactive Poster Sessions

This format offers presenters the opportunity to display their work graphically in a traditional poster session format. Displays should fit on the 48" (long) x 36" (high) trifold boards provided and should include a brief abstract in large typescript. Audience members will have approximately 90 minutes to circulate throughout the room to view the posters and interact with the presenters. Each presenter must set up the display prior to the start of the session and then remove it promptly at the end of the session. Each presenter is expected to disseminate a paper during the session, unless a summary of the poster is on the NARST Proceedings 2009 CD.

Guidelines for Meeting Presenters

- Go to the designated room at least 10 minutes early.
- Greet the presider/discussant.
- NARST provides the LCD and screen in each presentation room. NARST does not provide computers. So, you must have your own notebook computer or you may put your file on a USB flash drive in advance, in case you will be using another presenter's computer for your presentation.
- Check your understanding of the LCD projector and any other audiovisual equipment prior to the session.
- Keep presentation within the designated time limit.
- Invite audience comments and questions.

Guidelines for Presiders and Discussants

We have accommodated most sessions with a presider, whose role is detailed below. For sessions without presiders, we are counting on the presenters to set aside time for discussion so that the audience participants can contribute to a discussion of the papers.

Presider Roles

- Arrive early at designated room and arrange furniture as per desires of presenters.
- Check and focus LCD projector.
- Check pronunciations of the names of the presenter and their institutions.
- With presenters, make a time plan, retaining the order of presenters in the program.
- Start session promptly.
- Introduce presenters and serve as timekeeper. Alert presenters when they have 5, 3, and 1 minute remaining.
- Facilitate discussion, assuring equitable involvement of audience members. Close session on time.

Discussant Roles

- Read papers before the session and have remarks prepared ahead of time.
- Perform presider duties as detailed above, if there is only a discussant for the session.
- After the presentation, make brief and cogent remarks on each paper with suggestions for future research.

Strand Key

STRAND 1 - Science Learning: Understanding and Conceptual Change
STRAND 2 - Science Learning: Contexts, Characteristics, and Interactions
STRAND 3 - Science Teaching-Primary School (Grades preK-6): Characteristics and Strategies
STRAND 4 - Science Teaching-Middle and High School (Grades 5-12): Characteristics and Strategies
STRAND 5 - College Science Teaching and Learning (Grades 13-20)
STRAND 6 - Science Learning in Informal Contexts
STRAND 7 - Pre-service Science Teacher Education
STRAND 8 - In-service Science Teacher Education
STRAND 9 - Reflective Practice
STRAND 10 - Curriculum, Evaluation, and Assessment
STRAND 11 - Cultural, Social, and Gender Issues
STRAND 12 - Educational Technology
STRAND 13 - History, Philosophy, and Sociology of Science
STRAND 14 - Environmental Education
STRAND 15 - Policy

A Special Thanks to our Sponsors and Exhibitors
National Science Teachers Association
Sense Publisher
Springer
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We acknowledge Wiley-Blackwell and their work as publisher of the
Journal of Research in Science Teaching - JRST

NARST Leadership Team 2008-2009

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2010 NARST Annual International Conference

The Program Chair invites NARST members and others to plan to participate in the 2010 NARST Annual International Conference and especially urges all members to start planning program proposals now during this year's conference.

VENUE: Philadelphia Marriott Downtown, 1201 Market Street, Philadelphia, PA USA.
THEME: *Research Improving Practice - Practice Informing Research*
DATES: Saturday, March 20 – Wednesday, March 24, 2010

SUBMISSION DEADLINE: The Program Chair or designate must receive your program proposals for the 2010 Annual International Conference by August 15, 2009. The deadline allows sufficient time for processing, reviewing and evaluating the many proposals. The original call for proposals will appear on the NARST website in June 2009.

2010 MEETING BACKGROUND INFORMATION: The 2010 NARST meeting will be in the 'City of Brotherly Love'-Philadelphia. The city was once the second-largest in the British Empire (after London), and the social and geographical center of the original 13 American colonies. Benjamin Franklin took a large role in Philadelphia's early rise to prominence. It was this city that gave birth to the American Revolution and American Independence, making Philadelphia a centerpiece of early American history.

No visit to Philly is complete without visiting Independence Hall and the Liberty Bell. For a taste of Philly, be sure to make a visit to Reading Terminal Market where among the 80 merchants you can sample the delectable culinary foods, breads and cheeses of the Amish, the signature 'Philly Cheese Steak', soft-pretzels with mustard, and the famous Italian hoagies. Fine dining is another feature of Philly.

Philadelphia is rich in science and cultural institutions as well. The major science museums include the Franklin Institute, the Academy of Natural Sciences, and the University of Pennsylvania Museum of Archaeology and Anthropology. The city is home to the Pennsylvania Academy of the Fine Arts, the Rodin Museum and the Philadelphia Museum of Art that features the steps made popular by the film Rocky.

See you in Philly!

Future Meeting Dates for NARST, NSTA, and AERA

2010	NSTA	Philadelphia	March 17 – 20
	AERA	Denver	April 30 – May 4
	NARST	Philadelphia	March 20 – 24
2011	NSTA	San Francisco	March 9 – 12
	AERA	New Orleans	April 8 – 12
	NARST	Orlando	April 2 – 6
2012	NSTA	Indianapolis	March 29 – April 1
	AERA	Vancouver	April 13 – 17
	NARST	Indianapolis	March 24 – 28

2008 Strand Coordinators

STRAND 1 **Science Learning, Understanding, and Conceptual Change**
Catherine Milne, Eric Wiebe

STRAND 2 **Science Learning: Contexts, Characteristics, and Interactions**
Wesley Pitts, Erin Dolan

STRAND 3 **Science Teaching –Primary School (Grades preK-6)**
Jan H. van Driel, Terry Shanahan

STRAND 4 **Science Teaching –Secondary School (Grades 5-12)**
Lisa Martin-Hansen, Helen Meyer

STRAND 5 **College Science Teaching (Grades 13-20)**
Kate Popejoy, Tahsin Khalid

STRAND 6 **Science Learning in Informal Contexts**
Tali Tal, Jin Kisiel

STRAND 7 **Pre-service Science Teacher Education**
Christina Schwarz, Amelia Wenk-Gotwals

STRAND 8 **In-Service Science Teacher Education**
Martina Nieswandt, Kimberly Fluet

STRAND 9 **Reflective Practice**
Jerine Pegg, Erin Peters

STRAND 10 **Curriculum, Evaluation, and Assessment**
Bruce Waldrip, Xiufeng Liu

STRAND 11 **Cultural, Social, and Gender Issues**
Magnia A. George, Bhaskar Upadhyay

STRAND 12 **Educational Technology**
Hsin-Kai Wu, Hee-Sun Lee

STRAND 13 **History, Philosophy, and Sociology of Science**
Agustin Adúriz-Bravo, Renee Schwartz

STRAND 14 **Environmental Education**
Rita Anne Hagevik, Eleanor Abrams, Teddie Phillipson-Mower

STRAND 15 **Policy**
Judy Dori, Sharon Lynch, Sarah Carrier

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1995	Dorothy L. Gabel
1996	Barry J. Fraser
1997	Thomas R. Koballa, Jr.
1998	Audrey B. Champagne
1999	Joseph S. Krajcik
2000	David F. Treagust
2001	Sandra K. Abell
2002	Norman G. Lederman
2003	Cheryl L. Mason
2004	Andy (Charles) Anderson
2005	John R. Staver
2006	James Shymansky
2007	Jonathan Osborne
2008	Penny J. Gilmer
2009	Charlene M. Czerniak

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(NARST created the position of Executive Secretary in 1975; the title was changed to Executive Director in 2003)

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John Staver	1990 – 1995
Art White	1995 – 2000
David Haury	2000 – 2002
John Tillotson	2002 – 2007
William C. Kyle, Jr.	2007 – 2012

JRST Editors

J. Stanley Marshall	1963 – 1966
H. Craig Sipe	1976 – 1968
James T. Robinson	1969
O. Roger Anderson	1970 – 1974
David P. Butts	1975 – 1979
James A. Shymansky	1980 – 1984
Russell H. Yeany, Jr.	1985 – 1989
Ron Good	1990 – 1993
William C. Kyle, Jr.	1994 – May 1999
Charles A. Anderson & James J. Gallagher	August 1999 – 2001
Dale R. Baker & Michael D. Piburn	2002 – 2005
J. Randy McGinnis & Angelo Collins	2006 - 2010

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J. Nathan Swift
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Marlene Thier
Burton E. Voss
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Robert Yager
Catherine Yeotis
Russell H. Yeany
Uri Zoller

NARST Award Winners

Distinguished Contributions to Science Education Through Research

This award is presented at the Annual International Conference but is bestowed only when a superior candidate is identified. It is given to recognize an individual who, through research over an extended period of time, has made outstanding and continuing contributions, provided notable leadership, and made a substantial impact in the area of science education.

1986	Anton E. Lawson
1987	Paul DeHart Hurd
1988	John W. Renner
1989	Willard Jacobson
1990	Joseph D. Novak
1991	Robert L. Shrigley
1992	Pinchas Tamir
1993	Jack Easley, Jr.
1994	Marcia C. Linn
1995	Wayne W. Welch
1996	Carl F. Berger
1997	Rosalind Driver
1998	James J. Gallagher
1999	Peter J. Fensham
2000	Jane Butler Kahle
2001	John K. Gilbert
2002	Audrey B. Champagne
2003	Barry J. Fraser
2004	Robert E. Yager
	Paul Black
2005	John C. Clement
2006	David Treagust
2007	Kenneth Tobin
2008	Dorothy Gabel
2009	Peter W. Hewson
	Léonie Jean Rennie
	Wolff-Michael Roth

JRST Award

The JRST Award is given annually to the *Journal of Research in Science Teaching* article that is judged the most significant publication for that year.

Year	Awardee
1974	Donald E. Riechard and Robert C. Olson
1975	Mary Budd Rowe
1976	Marcia C. Linn and Herbert C. Thier
1977	Anton E. Lawson and Warren T. Wollman
1978	Dorothy L. Gabel and J. Dudley Herron
1979	Janice K. Johnson and Ann C. Howe
1980	John R. Staver and Dorothy L. Gabel
(tie)	Linda R. DeTure
1981	William C. Kyle, Jr.
1982	Robert G. Good and Harold J. Fletcher
(tie)	F. David Boulanger
1983	Jack A. Easley, Jr.
1984	Marcia C. Linn, Cathy Clement and Stephen Pulos
1985	Julie P. Sanford
1986	Anton E. Lawson
1987	Russell H. Yeany, Kueh Chin Yap, and Michael J. Padilla
1988	Kenneth G. Tobin and James J. Gallagher
1988 (tie)	Robert D. Sherwood, Charles K. Kinzer, John D. Bransford and Jeffrey J. Franks
	Anton E. Lawson
1989	Glen S. Aikenhead
1990	Richard A. Duschl and Emmett L. Wright
1991	E. P. Hart and I. M. Robottom
1992	John R. Baird, Peter J. Fensham, Richard E. Gunstone, and Richard T. White
1993	Nancy R. Romance and Michael R. Vitale
1994	E. David Wong
1995	Stephen P. Norris and Linda M. Phillips
1996	David F. Jackson, Elizabeth C. Doster, Lee Meadows, and Teresa Wood
1997	C.W.J.M. Klassen and P.L. Linjse
1998	Julie Bianchini
1999	Phillip M. Sadler
2000	Allan G. Harrison, J. Grayson, and David F. Treagust
2001	Fouad Abd-El-Khalick Norman G. Lederman
2002	Andrew Gibert and Randy Yerrick
2003	Sofia Kesidou and Jo Ellen Roseman
2004	Jonathan Osborne, Sue Collins, Mary Ratcliffe, Robin Millar and Richard Duschl
2005	Jonathan Osborne Sibel Erduran Shirley Simon
2006	Troy D. Sadler Dana L. Zeidler
2007	Jerome Pine Pamela Aschbacher Ellen Roth Melanie Jones Cameron McPhee Catherine Martin Scott Phelps Tara Kyle and Brian Foley
2008	Christine Chin
2009	Kihyun Ryoo Bryan Brown

Outstanding Paper Award

The Outstanding Paper Award is given annually for the paper or research report presented at the Annual International Conference that is judged to have the greatest significance and potential in the field of science education.

Year	Awardee
1975	John J. Koran
1976	Anton E. Lawson
1977	no award
1978	Rita Peterson
1979	Linda R. DeTure
1980	M. James Kozlow and Arthur L. White
1981	William Capie, Kenneth G. Tobin, and Margaret Boswell
1982	F. Gerald Dillashaw and James R. Okey
1983	William C. Kyle, Jr., James A. Shymansky, and Jennifer Alport
1984	Darrell L. Fisher and Barry J. Fraser
1985	Hanna J. Arzi, Ruth Ben-Zvi, and Uri Ganiel
(tie)	Russell H. Yeany, Kueh Chin Yap, and Michael J. Padilla
1986	Barry J. Fraser, Herbert J. Walberg, and Wayne W. Welch (tie)
1987	Robert D. Sherwood
1988	Barry J. Fraser and Kenneth G. Tobin
1989	James J. Gallagher and Armando Contreras
1990	Patricia L. Hauslein, Ronald G. Good, and Catherine Cummins
1991	Nancy R. Romance and Michael Vitale
1992	Patricia Heller Ronald Keith and Scott Anderson
1993	Wolff-Michael Roth
1994	Wolff-Michael Roth and Michael Bowen
1995	Wolff-Michael Roth
1996	Nancy J. Allen
1997	no award
1998	Wolff-Michael Roth, Reinders Duit, Michael Komorek, and Jens Wilbers
1999	Lynn A. Bryan
2000	Joseph L. Hoffman and Joseph S. Krajcik
2001	Allan G. Harrison
2002	Carolyn Wallace Keys Eun-Mi Yang Brian Hand and Liesl Hohenshell
2003	Wolff-Michael Roth
2004	Joanne K. Olson Sharon J. Lynch, Joel Kuipers, Curtis Pyke and Michael Szesze
2005	Chi Yan Sui, David Treagust and Michael Szesze
2006	Leema Kuhn and Brian Reiser
2007	Eugene L. Chiappetta Tirupalavanam G. Ganesh Young H. Lee and Marianne C. Phillips
2008	Guy Ashkenazi and Lana Tockus-Rappoport
2009	Jrène Rahm

Outstanding Doctoral Dissertation Award

This award was established in 1992 to be given annually for the Doctoral Dissertation judged to have the greatest significance in the field of science education.

Year	Awardee	Major Professor
1992	René Stofflett	Dale R. Baker
1993	Julie Gess-Newsome	Norman G. Lederman
1994	Carolyn W. Keys	Burton E. Voss
1995	Jerome M. Shaw	Edward Haertel
1996	Christine M. Cunningham	William L. Carlsen
1997	Jane O. Larson	Ronald D. Anderson
1998	Kathleen Hogan	Bonnie K. Nastasi
1999	Fouad Abd-El-Khalick	Norman G. Lederman
2000	Danielle Joan Ford	Annemarie S. Palinscar
2001	Iris Tabak	Brian Reiser
2002	Mark Girod	David Wong
2003	Hsin-Kai Wu	Joseph Krajcik
2004	David L. Fortus	Ronald Marx and Joseph Krajcik
2005	Thomas Tretter	Gail M. Jones
2006	Stacy Olitsky	Kenneth Tobin
2007	Julia Plummer	Joseph S. Krajcik
2008	Victor Sampson	Douglas Clark
2009	Lei Liu	Cindy E. Hmelo-Silver

Outstanding Master's Thesis Award

This award was established in 1995 to be given annually for the Master's Thesis judged to have the greatest significance in the field of science education. It was last awarded in 2002.

Year	Awardee	Major Professor
1995	Moreen K. Travis	Carol L. Stuessy
1996	Lawrence T. Escalada	Dean A. Zollman
1997	C. Theresa Forsythe	Jeffrey W. Bloom
1998	Reneé D. Boyce	Glenn Clark
1999	Andrew B. T. Gilbert	Randy K. Yerrick
2000	Rola Fouad Khishfe	Fouad Abd-El-Khalick
2002	Laura Elizabeth Slocum	Marcy Hamby Towns

Early Career Research Award

The Early Career Research Award is given annually to the early researcher who demonstrates the greatest potential to make outstanding and continuing contributions to educational research. The recipient will have received his/her Doctoral degree within five years of receiving the award.

Year	**Awardee**
1993	Wolff-Michael Roth
1994	Deborah J. Tippins
1995	Nancy B. Songer
1996	Mary B. Nakhleh
1997	Peter C. Taylor
1998	J. Randy McGinnis
1999	Craig W. Bowen
	Gregory J. Kelly
2000	Angela Calabrese Barton
2001	Julie A. Bianchini
2002	Alan G. Harrison
2003	Fouad Abd-El-Khalick
2004	Grady J. Venville
2005	Randy L. Bell
2006	Heidi Carlone
2007	Bryan A. Brown
2008	Hsin-Kai Wu
2009	Troy D. Sadler

Classroom Applications Award

The Classroom Applications Award was established in 1979. The award was given annually to authors whose papers were presented at the previous Annual Meeting and judged to be outstanding in terms of emphasizing classroom application of research in science education. The award was last presented in 1991.

Year	Awardee(s)
1980	Livingston S. Schneider and John W. Renner
(Five Equal Awards)	Heidi Kass and Allan Griffiths
	Ramona Saunders and Russell H. Yeany
	Joe Long, James R. Okey, and Russell H. Yeany
	M. James Kozlow and Arthur L. White
1981	Dorothy L. Gabel, Robert D. Sherwood, and Larry G. Enochs
(Four Equal Awards)	Wayne Welch, Ronald D. Anderson, and Harold Pratt
	Mary Ellen Quinn and Carolyn Kessler
	P. Ann Miller and Russell H. Yeany
1982	Louise L. Gann and Seymour Fowler
(Four Equal Awards)	Dorothy L. Gabel and Robert D. Sherwood
	Thomas L. Russell
	Joseph C. Cotham

1983	Robert D. Sherwood, Larry G. Enochs, and Dorothy L. Gabel
1984 (Four Equal Awards)	Mary Westerback, Clemencia Gonzales, and Louis H. Primavera Kenneth G. Tobin Hanna J. Arzi, Ruth Ben-Zvi, and Uri Ganiel Charles Porter and Russell H. Yeany
1985 (Three Equal Awards)	Dan L. McKenzie and Michael J. Padilla Margaret Walkosz and Russell H. Yeany Kevin C. Wise and James R. Okey
1986 (Four Equal Awards)	Sarath Chandran, David F. Treagust, and Kenneth G. Tobin Darrell L. Fisher and Barry J. Fraser Dorothy L. Gabel, Stanley L. Helgeson, Joseph D. Novak, John Butzow, and V. K. Samuel Linda Cronin, Meghan Tweist, and Michael J. Padilla
1987	Dorothy L. Gabel, V. K. Samuel, Stanley L. Helgeson, Saundra McGuire, Joseph D. Novak, and John Butzow
1988	Uri Zoller and Benn Chaim
1989	James D. Ellis and Paul J. Kuerbis
1990	Dale R. Baker, Michael D. Piburn, and Dale S. Niederhauser
1991	David F. Jackson, Billie Jean Edwards, and Carl F. Berger

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(10) Mei-Hung Chiu (International Coordinator)	mhchiu@ntnu.edu.tw
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Schedule at a Glance

Thursday, April 16

3:00 PM - 7:00 PM	NARST Executive Board Meeting Session #1

Friday, April 17

8:00 AM - 4:30 PM	NARST Executive Board Meeting Session # 2
1:00 PM - 5:00 PM	Three of three Pre-Conference Workshops
6:00 PM - 7:00 PM	Mentor-Mentee Nexus
7:00 PM - 9:30 PM	Presidential/Welcome Reception: All are welcome-Free appetizers and cash bar.

Saturday, April 18

7:00 AM - 8:15 AM	Committee Meetings
8:30 AM - 9:45 AM	Plenary #1: Linda Darling Hammond, Stanford University
9:45 AM - 10:15 AM	Break
10:15 AM - 6:15 PM	Concurrent Sessions
10:15 AM - 11:45 AM	Session #1
12:00 noon - 12:45 PM	NARST Business Meeting (box lunches provided for attendees who have signed up)
1:00 PM - 2:30 PM	Session #2
2:30 PM - 3:00 PM	Break
3:00 PM - 4:30 PM	Session #3 – Poster Time for All Posters
4:45 PM - 6:15 PM	Session #4
6:30 PM - 7:30 PM	Graduate Student Forum
7:00 PM - 9:00 PM	JRST Editorial Board Meeting/Dinner (Meeting open/Dinner by invitation only)

Sunday, April 19

7:00 AM - 8:15 AM	Committee Meetings
8:30 AM - 10:00 AM	Concurrent Sessions
8:30 AM - 10:00 AM	Session #5
10:00 AM - 10:30 AM	Break
10:30 AM - 11:45 AM	Plenary #2: Leona Schauble, Vanderbilt University
12:00 noon – 1:45 PM	Awards Luncheon
2:00 PM - 5:30 PM	Concurrent Sessions
2:00 PM - 3:30 PM	Session #6
3:30 PM - 4:00 PM	Break
4:00 PM - 5:30 PM	Session #7
5:45 PM - 6:45 PM	International Journal of Science and Mathematics Education (IJSME) Editorial Board Meeting-By invitation only.
5:45 PM - 6:45 PM	New Researcher and Junior Faculty Early Career Discussion
7:00 PM - 9:00 PM	Equity Dinner (off site)

Monday, April 20

7:00 AM - 8:15 AM	Strand Meetings
8:30AM - 6:15 PM	Concurrent Sessions
8:30 AM - 9:45 AM	Session #8
9:45 AM - 10:15 AM	Break
10:15 AM - 11:45 AM	Session #9
12:00 - 12:45 PM	Lunch on Your Own
1:00PM - 2:30 PM	Session #10
2:30PM - 3:00 PM	Break
3:00 PM - 4:30 PM	Session #11
4:45 PM - 6:15 PM	Session #12
6:30 PM - 9:30 PM	Elm Street Band (Enjoy this “California Attitude” Band. Appetizers sponsored by NARST and a cash bar.)
8:00 PM - 10:00 PM	Social - FARSE

Tuesday, April 21

8:00 AM - 11:30 AM	NARST Executive Board Meeting #3

Thursday, April 16, 2009

NARST Executive Board Meeting Session #1
3:00pm – 7:00pm, Salon VI

All current NARST Board Members must be in attendance. Newly elected Board Members are welcome to attend.

Friday, April 17, 2009

NARST Executive Board Continental Breakfast
7:30am – 8:00am, Salon IV

All current NARST Board Members must be in attendance. Newly elected Board Members are welcome to attend.

NARST Executive Board Meeting Session #2
8:00am – 4:30pm, Salon VI

All current NARST Board Members must be in attendance. Newly elected Board Members are welcome to attend.

S0.1 Pre Conference Workshop-Equity and Ethics Committee Sponsored
Grand Challenges and Great Opportunities in Science Education for Scholars of Color
1:00pm – 5:00pm, Harbor Room

Maria Rivera, Barnard College
Felicia Moore Mensah, Columbia University
Eileen C. Parsons, University of North Carolina
Jerome Shaw, University of California-Santa Cruz
Claudette Giscombe, University of Massachusetts-Amherst
Sumi Hagiwara, Montclair State University
Malcolm Butler, University of South Florida

S0.2 Pre Conference Workshop-Research Committee Sponsored
From Teaching to "Know" – to Learning to "Think"; Science Education for Sustainability
1:00pm – 5:00pm, Pacific Room

Uri Zoller, University of Haifa, Israel

S0.3 Pre Conference Workshop-Research Committee Sponsored
How Can We Plug the Hole in the Bucket? Addressing Beginning Science Teacher Retention Issues Before It's Too Late
1:00pm – 5:00pm, Salon VII & VIII

Donna R. Sterling, George Mason University
Wendy M. Frazier, George Mason University
Jason Calhoun, Prince William County Schools
Myra Thayer, Fairfax County Public Schools

Evening/Social Events

Membership and Elections Committee Sponsored Session
Mentor-Mentee Nexus

Informal discussion: Early career NARST members are matched with more seasoned members to help launch or expand professional networks. We encourage all NARST members who are early in their professional career to attend this session.

6:00pm – 7:00pm, Terrace Room

Laura Henriques, California State University, Long Beach
April D. Adams, Northeastern State University
Brian Fortney, University of Texas at Austin

Presidential/Welcome Reception

Social event: This is the opening welcome for all NARST members. All NARST members are encouraged to attend to network and socialize with colleagues. There will be free appetizers and a cash bar.

7:00pm – 9:30pm, North Tower Foyer

Saturday, April 18, 2009

Committee Meetings

7:00am – 8:15am

All members of NARST committees are required to attend the committee meetings. The meetings are open to other NARST members interested in attending the meeting.

Awards Committee Chairs & Co-Chairs Meeting

7:00am – 8:15am, Salon I

Dana Zeidler (Co-Chair)
Phil Scott (Co-Chair)
Anil Banerjee
Ann Cavallo
Deborah Tippins
Julie Kittleson
Hsiao-Ching She
Deborah L. Hanson
Larry Flick
Randy Bell
David Treagust
Kenneth Tobin

Equity and Ethics Committee Meeting

7:00am – 8:15am, Salon VI

Valarie L. Akerson (Chair)
Heidi Carlone
Maria Rivera
Gayle Buck
Felicia Moore
Lisa Martin-Hansen
Jrene Rahm
Michiel van Eijck
Sumi Hagiwaraas
Kathy Fadigan

External Policy and Relations Committee Meeting

7:00am – 8:15am, Salon VIII

Lynn Bryan (Co-Chair)
Betsy Davis (Co-Chair)
Janet Carlsen-Powell
Julie Luft
Eileen Parsons
Carla C. Johnson
Mike Vitale
Sharon Lynch
Christopher Miller
Andrew Shouse
Kevin Holtz

Research Committee Meeting

7:00am – 8:15am, Grand Ballroom D

Randy Yerrick (Co-Chair)
Troy Sadler (Co-Chair)
Martina Nieswandt
Kadir Demir
Julia V. Clark
Anita Roychoudhury
Dale R. Baker
Gavin Fulmer
Ajda Kahveci
James Otuka
Colette Murphy

Membership and Election Committee Meeting

7:00am – 8:15am, Grand Ballroom F

Reinders Duit (Chair)
Penny J. Gilmer (Co-Chair)
Kathryn Drago
Laura Henriques
Catherine Koehler
Mary Atwater
Julia (Julie) Grady
James Tarleton Mcdonald III
Jan van Driel
April Adams
Adin Amirshokoohi

International Committee Meeting

7:00am – 8:15am, Grand Ballroom G

Mei-Hung Chiu (International Coordinator)
Eduardo Mortimer
Soonhye Park
Sibel Erduran
Barbara G. Ladewski
Uri Zoller
Irene Osisioma
Max Dass
Knut Neumann
Feral Ogan-Bekiroglu

Program Committee Meeting

7:00am – 8:15am, Garden 1

All strand coordinators must attend. The purpose of the meeting is to review the previous year's process for calling for and reviewing papers for the conference and to discuss improvements to the upcoming year's process. This is also an opportunity to begin to work with President-Elect, Rick Duschl, in planning next year's conference.

Charlene M. Czerniak, President
Rick Duschl, President-elect
Catherine Milne
Eric Wiebe
Wesley Pitts
Erin Dolan
Jan H. van Driel
Terry Shanahan
Lisa Martin-Hansen
Helen Meyer
Kate Popejoy
Tahsin Khalid
Tali Tal
Jim Kisiel
Christina Schwarz
Amelia Wenk-Gotwals
Martina Nieswandt

Kimberly Fluet
Jerine Pegg
Erin Peters
Bruce Waldrip
Xiufeng Liu
Magnia A. George
Bhaskar Upadhyay
Hsin-Kai Wu
Hee-Sun Lee
Agustín Adúriz-Bravo
Reneé Schwartz
Eleanor Abrams
Rita Anne Hagevik
Teddie Phillipson-Mower
Sharon Lynch
Sarah Carrier

Publications Advisory Committee Meeting
7:00am – 8:15am, Garden 3

Carla Zembal-Saul (Chair)
Hedy Moscovici
Tamara Nelson
Kate McNeill
Reneé Schwartz
Kathy Roth
Tali Tal
Len Annetta
Kate Popejoy
Gill Roehrig
J. Randy McGinnis (JRST Co-Editor)
Angelo Collins (JRST Co-Editor)

Plenary Session
PL.1 Teaching and Learning for the 21st Century
8:30am – 9:45am, Grand Ballroom A


Linda Darling Hammond

Presider: Charlene M. Czerniak, The University of Toledo
Presenter: Linda Darling Hammond, Stanford University, Charles E. Ducommon Professor of Education

Break
9:45am – 10:15am

Concurrent Session #1
10:15am – 11:45am

Presidential Invited Session

S1.1 Between Sputnik's Launch and Halley's Return: Grand Challenges at the Crossroads
10:15am – 11:45am, Grand Ballroom D
Presider: Charlene M. Czerniak, The University of Toledo
Presenters: John Settlage, University of Connecticut
Adam Johnston, Weber State University

Equity and Ethics Committee Sponsored Session

S1.2 Opportunities and Challenges of Equitable Science: A Call for Action at Many Levels
10:15am – 11:45am, Grand Ballroom E
Presider: Jrene Rahm, University of Montreal
Discussant: Angela Calabrese Barton, Michigan State University
Presenters: Jrene Rahm, University of Montreal
Valarie L. Akerson, Indiana University
Dorish Ash, University of California, Santa Cruz
Mary Atwater, University of Georgia
Mary Bang, TERC & American Indian Center of Chicago
Cory A. Buxton, University of Georgia
Angela Calabrese Barton, Michigan State University

Strand 1: Science Learning, Understanding and Conceptual Change

S1.3 Poster Symposium: Learning Progressions for Principled Accounts of Processes in Socio-Ecological Systems
10:15am – 11:45am, Grand Ballroom F
Presider: Charles W. Anderson, Michigan State University
Discussants: Richard A. Duschl, Pennsylvania State University
Joseph Krajcik, University of Michigan
Presenters: Charles W. Anderson, Michigan State University
Richard A. Duschl, Pennsylvania State University
Joseph Krajcik, University of Michigan
Lindsey Mohan, Michigan State University
Hui Jin, Michigan State University
Jing Chen, Michigan State University
Edna Tan, Michigan State University
Kristin L. Gunckel, University of Arizona
Beth A. Covitt, Michigan State University
Josephine Zesaguli, Michigan State University
Blakely K. Tsurusaki, Washington State University, Pullman

S1.4 Symposium: Model-Based Learning in Experts and in the Classroom
10:15am – 11:45am, Grand Ballroom G
Presider: Maria C. Nunez-Oviedo, University of Concepcion, Chile

S1.4.1 Examining Processes and Outcomes of Applying Model Based Teaching and Learning Processes in ST1- Teaching Practices at the Primary School Level
Maria C. Nunez-Oviedo, University of Concepcion, Chile
Carla Barria, University of Concepcion, Chile
Gonzalo Saez, University of Concepcion, Chile
Sergio Rojas, University of Concepcion, Chile
Jonathan Vargas, University of Concepcion, Chile
Loreto Venegas, University of Concepcion, Chile

S1.4.2 Model Co-Construction in High School Physics: A Case Study of Teachers' Intended Instructional Pathways and Recovery Routes
E. Grant Williams, University of Massachusetts – Amherst

S1.4.3 Extreme Case Reasoning and Model Based Learning in Experts and Students
A. Lynn Stephens, University of Massachusetts - Amherst

S1.4.4 Model Construction in Scientists
John J. Clement, University of Massachusetts – Amherst

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S1.5 Related Paper Set: Examining Intervention Efforts to Establish Equitable Science Learning Environments
10:15am – 11:45am, Garden 1
Discussant: Kenneth Tobin, CUNY

S1.5.1 From Remediation to Shared Spaces: Implications for Teachers of Historically Low Achieving Science Students
Randy K. Yerrick, SUNY-UB
Anna Luizzo, SUNY-UB
Kenneth Tobin, CUNY

S1.5.2 "Who Are You Callin' Expert?": Using Student Narratives to Redefine Expertise and Advocacy Lower Track Science
Jennifer Schiller, SUNY-UB
Randy K. Yerrick, SUNY-UB

S1.5.3 Developing a Framework for Science Teacher Knowledge By Examining Miscues in Diverse Settings
Joseph Johnson, SUNY-UB
Randy K. Yerrick, SUNY-UB
Jennifer Schiller, SUNY-UB
Zaynab Alnakeeb, SUNY-UB
Dara Dorsey, SUNY-UB

S1.5.4 Initiating Technological and Pedagogical Shifts in Low Achieving Urban Minority Classrooms
Brian Meyer, SUNY-UB
Randy K. Yerrick, SUNY-UB
Suzanne Miller, SUNY-UB
Mary Thompson, SUNY-UB

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S1.6 SC-Paper Set: Exploring the Nature of Science and Knowledge Construction in Science Education
10:15am – 11:45am, Garden 3
Presider: Femi Otulaja, City University of New York

S1.6.1 High School Students' Beliefs about Nature of Knowledge and Nature of Knowing: Impact of Constructivist Philosophy
Feral Ogan-Bekiroglu, Marmara University
Gulsen Sengul, Marmara University

S1.6.2 A Call for Being Explicit About Science: Inquiry Combined With Instruction in NOS as a Multicultural Education Approach
Xenia Meyer, Cornell University
Barbara Crawford, Cornell University

S1.6.3 What is Technology? A Theoretical Framework for Investigating Student Conceptions about the Nature of Technology
Nicole DiGironimo, University of Delaware

S1.6.4 Exploring Secondary Students' Views of the Nature of Science and Writing in Science
Isha DeCoito, York University

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies

S1.7 SC-Paper Set: Technologies to Promote Science Understanding and Inquiry
10:15am – 11:45am, Garden 2
Presider: Dawn Sutherland, University of Winnipeg

S1.7.1 Integrating Scientific Concepts of Motion and Mathematics Concepts of Graphing Using a Motion Detector in a Second and Third Grade Mixed Age Classroom
Jason Kahn, Tufts University
Ronald K. Thornton, Tufts University

S1.7.2 Science Notebooks as a Predictor of Achievement in Reading, Writing, Math, and Science, and of Higher-level Thinking in Science Classrooms
Stephen R. Getty, BSCS Center for Curriculum Development
Joseph A. Taylor, BSCS Center for Research and Evaluation
Linda B. Mooney, Educational Consultant
Paul J. Kuerbis, Colorado College

S1.7.3 Promoting Reform-Based Science Teaching through the Use of Web-based Technology Lessons
Moses K. Ochanji, California State University

S1.7.4 Examining Science Inquiry Practices in the Elementary Classroom through Science Notebooks
Eric N. Wiebe, North Carolina State University
Lauren P. Madden, North Carolina State University
John C. Bedward, North Carolina State University
James Minogue, North Carolina State University
Michael Carter, North Carolina State University

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies

S1.8 SC-Paper Set: Development of Critical Thinking Skills in Secondary Science
10:15am – 11:45am, Salon III
Presider: Victor Sampson, Florida State University

S1.8.1 Evaluative Thinking Capability within Two Cultures: A Case of Secondary Science Education
Tami Levy Nahum, University of Haifa-Oranim, Israel
Ibtesam Azaiza, University of Haifa-Oranim, Israel
Naji Kortam, University of Haifa-Oranim, Israel
David Ben-Chaim, University of Haifa-Oranim, Israel
Uri Zoller, University of Haifa-Oranim, Israel

S1.8.2 Teachers' Meanings and Intentions in Constructing Concept Maps While Learning to Teach Semiconductors
Marissa Rollnick, Wits University
Fhatuwani Mundalamo, Wits University
Shirley Booth, Wits University and Lund University

S1.8.3 Design Study Methodology to Develop an Intervention to Enhance Scientific Argumentation Skills of Middle School Students
James D. Ellis, University of Kansas
Janis Bulgren, University of Kansas
Kathy Carlsen, University of Kansas

S1.8.4 A Distributed Knowledge Community for Science Teachers: The Impact of Peer Exchange and Reflection Tools
Cheryl-Ann Madeira, University of Toronto
James D. Slotta, University of Toronto

Strand 5: College Science Teaching and Learning (Grades 13-20)

S1.9 SC-Paper Set: The Pedagogical and Career Path: Graduate Teaching Assistant to PhD Scientist
10:15am – 11:45am, Salon IV
Presider: Janelle M. Bailey, University of Nevada, Las Vegas

S1.9.1 Situating the Preparation of Graduate Physics Teaching Assistants in Their "Funds of Knowledge" and Leveraging Their Potential as Agents of Critical Change
Sreyashi Jhumki Basu, New York University
Allen Mincer, New York University

S1.9.2 Relating Motivational Orientation to Indicators of Success for Physical Scientists
Zahra Hazari, Clemson University
Geoff Potvin, Clemson University
John Almarode, University of Virginia
Robert H. Tai, University of Virginia

S1.9.3 Lesson Study in the Undergraduate Context: A Case of Graduate Teaching Assistants in the Sciences
Sharon Dotger, Syracuse University

S1.9.4 Reform in Undergraduate Science Laboratories: Beliefs and Practices of Graduate Teaching Assistants Following Participation in a Teacher Certificate Program
Tracie M. Addy, North Carolina State University
Margaret R. Blanchard, North Carolina State University

Strand 6: Science Learning in Informal Contexts

S1.10 SC-Paper Set: Perspectives on Educators in Informal Settings
10:15am – 11:45am, Salon V
Presider: Scott Randol, Oregon State University

S1.10.1 Teaching and Learning with Do-It-Yourself Science Kits in School
Leonie J. Rennie, Curtin University of Technology
Christine Howitt, Curtin University of Technology
Rosemary S. Evans, Curtin University of Technology
Fiona E. Mayne, Curtin University of Technology

S1.10.2 Informal Science Institutions as Incubators for Science Teachers: Documenting Identity Development in Floor Staff
Preeti Gupta, New York Hall of Science
Laura Saxman, CUNY

S1.10.3 Why Do They Do It? Identifying Factors That Characterize Teachers Who Use Informal Science Institutions
James Kisiel, California State University, Long Beach

Strand 7: Pre-service Science Teacher Education

S1.11 SC-Paper Set: Community, Context, and Informal Issues in Preservice Science Teacher Edcuation
10:15am – 11:45am, Salon II
Presider: Magnia George

S1.11.1 Science Teacher Retention in Today's Urban Schools: A Study of Challenges and Opportunities
Hedy Moscovici, California State University

S1.11.2 Authentic Contexts in Preservice Teacher Education: Student and Parental Involvement through Culturally Relevant Science Teaching
Cherie A. McCollough, Texas A&M University

S1.11.3 Fostering the Development of Effective Science Teachers through Community-Based Service-Learning
Neporcha T. Cone, University of Miami

S1.11.4 Transforming Science Teacher Preparation by Bridging Formal and Informal Science Education: A Focus on Drawings as Evidence
Randy McGinnis, University of Maryland
Phyllis Katz, University of Maryland
Emily Hestness, University of Maryland
Kelly Riedinger, University of Maryland
Amy Dai, University of Maryland
Rebecca Pease, University of Maryland
Gili Marbach-Ad, University of Maryland
Scott J. Dantley, Coppin State University

Strand 8: In-service Science Teacher Education

S1.12 SC-Paper Set: Teacher as Researcher
10:15am – 11:45am, Salon I
Presider: Xavier Fazio, Brock University

S1.12.1 Working to Describe Teacher Development: What Happens as a Result of Research Experiences for Teachers
Sherry A. Southerland, Florida State University
Barry Golden, Florida State University
Yavuz Saka, Florida State University
Patricia Dixon, Florida State University
Ellen Granger, Florida State University
Patrick Enderle, Florida State University

S1.12.2 An Investigation of Teachers' Motivation, Expectations and Changes to Teaching Practices due to RET Professional Development Involvement
Margareta Pop, North Carolina State University
Patricia Dixon, Florida State University

S1.12.3 Conditions That Support Teacher Learning: An Examination of a Collaborative Action Research Project Using a Complexity Framework
Xavier Fazio, Brock University

Strand 10: Curriculum, Evaluation, and Assessment

S1.13 SC-Paper Set: Issues in Performance and Standardized Tests
10:15am – 11:45am, Garden 4
Presider: Joseph Zawicki, State University of New York College at Buffalo

S1.13.1 Standardized Science Tests: Are We Testing Content Knowledge or Reading Level?
Adam Mitchell, Diamond Fork Junior High
Nikki L. Hanegan, Brigham Young University

S1.13.2 Mapping the Linguistic Landscape of Science Performance Assessments: Opportunities and Challenges for English Learners
Jerome M. Shaw, University of California Santa Cruz
George C. Bunch, University of California Santa Cruz
Edward R. Geaney, University of California Santa Cruz

S1.13.3 What Types of Cognitive Demands Do Standardized Testing Items Place on Students?
Amelia W. Gotwals, Michigan State University
Hayat Hokayem, Michigan State University
Tian Song, Michigan State University

S1.13.4 Modifying Performance Assessment Tasks According to Level, Structure, Transfer, Sequence, and Organization
Joe Engemann, Brock University
Anne Wright, Canisius College
Rodney Doran, State University of New York at Buffalo
Ethel Petrou, Erie County Community College
Joe Zawicki, Buffalo State College

Strand 11: Cultural, Social, and Gender Issues

S1.14 SC-Paper Set: Beyond Technique: Language in the Science Classroom
10:15am – 11:45am, Salon VII
Presider: Christopher Emdin, Columbia University

S1.14.1 Reloading and Repositioning Science Language for ELL Students: A New Look At Sheltered Instruction
Molly H. Weinburgh, Texas Christian University
Cecilia Silva, Texas Christian University
Tammy Oliver, Texas Christian University
Valerie Weilard, Texas Christian University

S1.14.2 Coming to Terms with Language: The Translation of Technical Terminology in Science Textbooks
Cassie F. Quigley, Indiana University
Alan Oliveira, University of New Albany- SUNY
Gayle A. Buck, Indiana University

S1.14.3 Isn't that Just Good Teaching? : Language, Identity, and Science Teaching & Learning
Bryan A. Brown, Stanford University
Salina Gray, Stanford University
Bryan Anthony Henderson, Stanford University

S1.14.4 Learning Science and English using Native-Language Aids
Stephanie A. Touchman, Arizona State University
Doug Clark, Arizona State University
Tira Skjerping, Arizona State University

Strand 12: Educational Technology

S1.15 SC-Paper Set: Technologies Enhancing Formative Assessment Practices
10:15am – 11:45am, Salon VIII
Presider: Carla Zembal-Saul, Penn State University

S1.15.1 Supporting Learners' Reflection through Comparing with Other Learners' Thinking: Development and Evaluation of Reflective Mapping Software
Akiko Deguchi, Utsunomiya University, Japan
Etsuji Yamaguchi, University of Miyazaki, Japan
Hideo Funaoi, Hiroshima University, Japan
Shigenori Inagaki, Kobe University, Japan

S1.15.2 Teachers' Implementation of a Classroom Response System for Performing Formative Assessment in Secondary Science/Math Classes
Hyunju Lee, University of Massachusetts Amherst
Allan Feldman, University of Massachusetts Amherst
Ian Beatty, University of Massachusetts Amherst and University of North Carolina at Greensboro

S1.15.3 Applying Computational Metaphor Identification to Middle School Students' Writing about Cellular Reproduction
Eric Baumer, University of California, Irvine
Lindsey E. Richland, University of California, Irvine
Bill Tomlinson, University of California, Irvine

S1.15.4 Dynamic Assessment Tools for Dynamic Constructs: The Case Of Molecular Reasoning
Dalit Levy, Center for Educational Technology, Israel

Strand 14: Environmental Education

S1.16 Symposium: Views of the Environment – Theory, Measurement, and Results
10:15am – 11:45am, Salon VI
Presider: Bruce Johnson, University of Arizona
Presenters: Bruce Johnson, University of Arizona
Riley E. Dunlap, Oklahoma State University
Franz X. Bogner, University of Bayreuth
Michael Wiseman, University of Bayreuth
Constantinos C. Manoli, University of Arizona

NARST Business Meeting
Free box lunch for the first 100 who sign up to attend; everyone is welcome to attend.
12:00pm – 12:45pm, Pacific Room

Concurrent Session #2
1:00pm – 2:30pm

Publications Advisory Committee Invited Session
S2.1 Engaging with Teachers around Science Education Research
1:00pm – 2:30pm, Grand Ballroom D
Presiders: Carla Zembal-Saul, Penn State University
Julie Luft, Arizona State University
Presenters: Carla Zembal-Saul, Penn State University
Julie Luft, Arizona State University
Scott McDonald, Penn State University
Felicia Moore, Columbia University
Barbara Crawford, Cornell University
April Luehmann, University of Rochester
Tamara Nelson, Washington State University
Celestine Pea, National Science Foundation

Strand 1: Science Learning, Understanding and Conceptual Change

S2.2 Symposium: Multiple Perspectives on Problem Solving in Physics
Presider: Kenneth Heller, University of Minnesota
1:00pm – 2:30pm, Grand Ballroom F
Discussants: Kenneth Heller, University of Minnesota
Chandralekha Singh, University of Pittsburgh
David Rosengrant, Kennesaw State University
Frances A. Mateycik, Kansas State University
Leonardo Hsu, University of Minnesota
Jennifer Docktor, University of Minnesota

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S2.3 SC-Paper Set: Culture, Social Context and the Discourse of Science Education
1:00pm – 2:30pm, Garden 2
Presider: Amy Trauth-Nare, Indiana University

S2.3.1 Utilizing the Three C's for Urban Science Education: Cogenerative dialogues, Coteaching, and Cosmopolitanism in the Science Classroom.
Christopher Emdin, Columbia University

S2.3.2 Multimodality and Inscriptions: Essential Components of a Multi-Representational Framework to Study Student Discourse
Kok-Sing Tang, University of Michigan

S2.3.3 Science Fairs & Emotions: A Discursive Approach To Anxiety
Giuliano Reis, University of Ottawa
Liliane Dionne, University of Ottawa
Louis Trudel, University of Ottawa
Leonard Klein, University of Ottawa
Chantal Helliwell, University of Ottawa

S2.3.4 A Model for Investigating Social Contexts with respect to Culture and Race: Examining Contextual Foundations on Instructional Practices
Eileen C. Parsons, University of North Carolina at Chapel Hill

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Strand 2: Science Learning: Contexts, Characteristics and Interactions

S2.4 Symposium: Critique to Learn Science
1:00pm – 2:30pm, Garden 3
Presider: Ji Shen, University of Georgia, Athens
Discussant: Marcia Linn, UC Berkeley
Presenters: Hsin-Yi Chang, National Kaohsiung Normal University
Douglas Clark, Arizona State University
Michael Ford, University of Pittsburgh
Victor Sampson, Florida State University
Iris Tabak, Ben Gurion University of the Negev
Roger Taylor, Vanderbilt University
Keisha Varma, University of Minnesota
Beat Schwendimann, UC Berkeley

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies

S2.5 SC-Paper Set: Examining Issues in Science Education at the Secondary Level
1:00pm – 2:30pm, Salon III
Presider: Sean Smith, Horizon Research, Inc.

S2.5.1 A Summer Institute as a Tool to facilitate NSF GK-12 Program Preparation
Xiaobo She, Texas Tech University
Jennifer A.Wilhelm, Texas Tech University
Darrellee R. Clem, Texas Tech University

S2.5.2 Experiencing Integration: Changes in One NSF GK-12 "Building Bridges" Cohort
Darrellee R. Clem, Texas Tech University
Jennifer A. Wilhelm, Texas Tech University
Xiaobo She, Texas Tech University

S2.5.3 The State of Science Education in Rural, High Poverty and Minority Schools
William R. Veal, College of Charleston

S2.5.4 Revealing Tensions between Curriculum and Teachers' Visions of Communities of Science Practice
David J. Grueber, Wayne State University

Strand 5: College Science Teaching and Learning (Grades 13-20)

S2.6 SC-Paper Set: Societal Issues in Science Instruction
1:00pm – 2:30pm, Salon IV
Presider: Patrick Enderle, Florida State University

S2.6.1 Nature of Science: A Look into Biology Undergraduate Knowledge
Marie C. Desaulniers Miller, North Dakota State University
Lisa M. Montplaisir, North Dakota State University
Gerald L. Ketterling, North Dakota State University

S2.6.2 College Students' Conceptions of Stem Cells, Stem Cell Research, and Cloning
James P. Concannon, Westminster College
Marcelle A. Siegel, University of Missouri-Columbia
Kristy L. Halverson, University of Missouri
Sharyn K. Freyermuth, University of Missouri-Columbia

S2.6.3 Risk Perception and the Knowledge Deficit Model: Nanotechnology Undergraduate Education
Grant E. Gardner, North Carolina State University
M. Gail Jones, North Carolina State University
Amy R. Taylor, University of North Carolina at Wilmington
Laura Robertson, North Carolina State University
Jennifer H. Forrester, North Carolina State University
Denise Krebs, North Carolina State University

S2.6.4 The Development of Biodiversity Curriculum
Hui-Ju Huang, California State University Sacramento
Yu-Teh K. Lin, National Taiwan University

Strand 6: Science Learning in Informal Contexts

S2.7 SC-Paper Set: Perspectives on Museum Staff and their Influence on Science Learning
1:00pm – 2:30pm, Salon V
Presider: Terence McClafferty

S2.7.1 Museum Educators' Views about Nature of Science
Gary M. Holliday, Illinois Institute of Technology
Norman G. Lederman, Illinois Institute of Technology
Martina Nieswandt, Illinois Institute of Technology

S2.7.2 Staff Members' Considerations about Visitors' Learning and the Scientific Content of Exhibitions
Eva Davidsson, Copenhagen Aarhus University
Anders Jakobsson, Malmö University

S2.7.3 How Do Staff Members in Science and Technology Centers Consider the Impact of Sponsors On the Scientific Content of an Exhibition?
Helene Sørensen, The Danish University of Education at Århus University
Eva Davidsson, Copenhagen Aarhus University

S2.7.4 Re-Examining the Theory and Practice of Scaffolding in Informal Learning Settings
Doris B. Ash, University of California, Santa Cruz
Judith Lombana, Museum of Science & Industry, Florida
Thao T. Mai, University of California, Santa Cruz
Wendy Dickinson, Museum of Science & Industry, Florida

Strand 7: Pre-service Science Teacher Education

S2.8 SC-Paper Set: Inquiry, Design and Art in Pre-service Teacher Education
1:00pm – 2:30pm, Salon II
Presider: Eric Eslinger, University of Delaware

S2.8.1 Guided Peer Discussions as a Scaffold for Developing Learning Progressions about Inquiry
Meredith A. Park Rogers, Indiana University
Cassie F. Quigley, Indiana University

S2.8.2 Use of Hypothesis Testing in First Inquiry Lessons Taught by Elementary Pre-service Teachers in a Science Methods Course
Barbara Sullivan-Watts, University of Rhode Island
Barbara Nowicki, University of Rhode Island
Betty J. Young, University of Rhode Island
Robert Pockalny, University of Rhode Island

S2.8.3 Pre-Service Elementary Teachers' Learning through LEGO Engineering Design Challenges
Ismail Marulcu, Boston College
Michael Barnett, Boston College
Kristen Wendell, Tufts University
Kathleen G. Connolly, Tufts University
Christopher G. Wright, Tufts University
Linda Jarvin, Tufts University
Chris Rogers, Tufts University

Strand 8: In-service Science Teacher Education

S2.9 SC-Paper Set: Discourse, Argumentation and Questioning
1:00pm – 2:30pm, Salon I
Presider: Margaret Blanchard, North Carolina State University

S2.9.1 The Impact of an Argue to Learn Professional Development Experience on Teacher Content Knowledge and Beliefs about Science
Kent J. Crippen, University of Nevada Las Vegas

S2.9.2 Question Analysis as a Tool to Understand Changes in Inquiry-Based Science Teaching: Strengths and Weaknesses
Margaret Blanchard, North Carolina State University

S2.9.3 Variations in the Modality of Science Teaching About Minerals Based On the Discourse Register and Language Code of Earth Science Classroom Discourse
Seung-Ho Maeng, Seoul National University
Chan-Jong Kim, Seoul National University

S2.9.4 Characterizing Teacher Verbal Interventions as a Baseline for a Personalized Program of Professional Development: The Challenge of Addressing Individual Needs
M. Teresa Guerra-Ramos, Cinvestav Monterrey
Victor H. Lira-Morales, Cinvestav Monterrey
Adrianna Gómez-Galindo, Cinvestav Monterrey

Strand 9: Reflective Practice

S2.10 SC-Paper Set: Action Research
1:00pm – 2:30pm, Grand Ballroom G
Presider: Tom McConnell, Ball State University

S2.10.1 "Take the Bull by the Horns": Using Action Research to Improve Questioning Strategies
Robert Kagumba, Western Michigan University
Reneé S. Schwartz, Western Michigan University

S2.10.2 A Teacher Inquiry Project: Chemistry Teachers' Sense-making of Students' Learning within the Context of Community-Based Inquiry Lessons
Youngjin Song, University of Northern Colorado
J. Steve Oliver, University of Georgia

S2.10.3 Examining Evidence-based Explanations in In-Service Science Teachers' Reflections
Cynthia C.M. Deaton, Clemson University
Thomas R. Koballa, University of Georgia
Lynn A. Bryan, Purdue University

S2.10.4 Improving Science Textbook Development through Action Research
Maurice DiGiuseppe, UOIT

Strand 10: Curriculum, Evaluation, and Assessment

S2.11 SC-Paper Set: Formative Assessment in the Classroom and Across the District
1:00pm – 2:30pm, Garden 4
Presider: Maria Araceli Ruiz-Primo, University of Colorado Denver

S2.11.1 Exploring the Usability of District-Wide Science Assessments by Administrators and Teachers for Improving Science Instruction and Learning
Sanlyn R. Buxner, University of Arizona
Christopher Harris, University of Arizona
Bruce Johnson, University of Arizona

S2.11.2 When Alignment Matters: A Model for Developing District-Wide Assessments that Align with Learning Goals Embedded in District Standards and Classroom Curricula
Elsa Schaub, University of Arizona
Christopher Harris, University of Arizona
Sanlyn Buxner, University of Arizona
Bruce Johnson, University of Arizona

S2.11.3 Confidence Wagering during Mathematics and Science Testing
Brady M. Jack, National Kaohsiung Normal University
Chia Ju Liu, National Kaohsiung Normal University
James A. Shymansky, University of Missouri at St. Louis
Houn Lin Chiu, National Kaohsiung Normal University

Strand 11: Cultural, Social, and Gender Issues

S2.12 SC-Paper Set: Addressing the Grand Challenge of…
1:00pm – 2:30pm, Salon VII
Presider: Tanya Cleveland Solomon, University of Michigan

S2.12.1 The Confluence of Constructivism and Policy Toward Intercultural Science Education
Claudia Khourey-Bowers, Kent State University

S2.12.2 A Case Study on an Undergraduate Student Interest Socio-Scientific Issues Based Curriculum Intervention
Kelly A. Schalk, University of Maryland

S2.12.3 The Accountability Pressures of NCLB and the Instructional Practices In Minority School Science Classes: Unintended Consequences
Obed Norman, Morgan State University
Charles Ault, Lewis & Clark College
Glenda Prime, Morgan State University
Kevin Cuff, University of California, Berkeley

S2.12.4 What Does Culturally Relevant Science Look Like? A Delphi Study
Dawn L. Sutherland, University of Winnipeg

Strand 12: Educational Technology

S2.13 SC-Paper Set: Application of Cognition Theories to Technology-Based Learning
1:00pm – 2:30pm, Salon VIII
Presider: Tom Moher, University of Illinois

S2.13.1 Language Mediated Haptic Cognition: Exploring the Role of Grounding Terms
James Minogue, North Carolina State University

S2.13.2 The Influence of Text-Graphic Integration and Individual Differences on Learning from Multimedia Presentations
Michelle Cook, Clemson University
Ryan Visser, Clemson University
Carol Wade, Clemson University

S2.13.3 The Effect of Two-Dimensional and Stereoscopic Presentation on Spatial Cognition Tasks
Aaron Price, Tufts University
Hee-Sun Lee, Tufts University

S2.13.4 Self-Directed Physics Learning Using Multimedia in Small Groups
Agnes Szabone Varnai, University of Paderborn, Germany
Peter Reinhold, University of Paderborn, Germany

Strand 13: History, Philosophy, and Sociology of Science

S2.14 SC-Paper Set: Elementary- and Middle-School NOS: Views, Evolution, and Assessment
1:00pm – 2:30pm, Garden 1
Presider: Igal Galili

S2.14.1 Grand Challenges: Bringing the Relationship between Science and Worldviews into the Classroom
Matthews R. Matthews, University of New South Wales

S2.14.2 Toward an Understanding of the Development of Student Views on Evolution
Ronald S. Hermann, Towson University

S2.14.3 Florida Teachers' Discomfort with Teaching Evolution: More than Just Religion
Samantha R. Fowler, University of South Florida
Gerry G. Meisels, University of South Florida

S2.14.4 Model for Assessing Elementary Students' Concepts of Nature of Science
Sufen Chen, National Taiwan University of Science and Technology
Sang-Chong Lieu, National Hualien University of Education
Wen-Hua Chang, National Taiwan Normal University
Shu-Fen Lin, National Chiao Tung University
Mao-Tsai Huang, National Academy of Educational Research

S2.14.5 Exploring Young Children's Beliefs about Science and Scientists
Tiffany R. Lee, University of Washington

Strand 14: Environmental Education

S2.15 Symposium: The Influenced of Culture and Nature on the Motivation of Indigenous Children to Learn Science
1:00pm – 2:30pm, Salon VI
Presider: Eleanor D. Abrams, University of New Hampshire
Presenters: Eleanor D. Abrams, University of New Hampshire
Chiung-Fen Yen, Providence University, Taiwan
Pauline Chinn, University of Hawai`i at Manoa
George E. Glasson, Virginia Tech
Margarita Cholymay, University of Hawai`i at Manoa
Michael Middleton, University of New Hampshire
Juliann Benson, University of New Hampshire
Absalom D. Phiri, Malawi Ministry of Education, Malawi
Ndalapa Mhango, Domasi College of Education, Malawi
Marilyn Lanier, Virginia Tech

Strand 15: Policy

S2.16 SC-Paper Set: Snapshots: How Science Education Policy is Made (or Not)
1:00pm – 2:30pm, Salon Grand Ballroom E

S2.16.1 The Evolution of Evolution in Florida's Next Generation Sunshine State Standards for Science
Lance E. King, Florida State University

S2.16.2 A Principal's Instructional Leadership: How does it Influence Elementary Science Amidst Contradictory Reforms
Kimberly S. Lanier, Florida State University
Alejandro Gallard, Florida State University
Sherry S. Southerland, Florida State University

S2.16.3 The Small School Movement and its Impact on Science Education in New York City
Keith Sheppard, Stony Brook University
Angela M. Kelly, City University of New York

Break
2:30pm – 3:00pm

Concurrent Session #3
3:00pm – 4:30pm

Strand 1: Science Learning, Understanding and Conceptual Change

S3.1 Poster Session
3:00pm – 4:30pm, Royal Ballroom

S3.1.1 Do Student Teachers Use the Same Conceptual Change Mechanism for Changing a Given Alternative Conceptions?
Mohamed Moustafa Ali, Alexandria University, Egypt
Medhat Ahmed Elnemer, Alexandria University, Egypt
Robert E. Yager, University of Iowa
Magda Habashi Soliman, Alexandria University, Egypt
Ahmed Kamel Elhussary, Alexandria University, Egypt
Fatma Fatouh Elgazar, Alexandria University, Egypt
Nabeel Abd Elwahed Fadl, Tanta University

S3.1.2 An Analysis of Conceptual Flow Patterns and Structures in the Physics Classroom
Haim Eshach, Ben Gurion University of the Negev

S3.1.3 Future Elementary Teachers Integrating Hypertext with Hands-On Experimentation in A Design-Based Context
Jacquelyn J. Chini, Kansas State University
N. Sanjay Rebello, Kansas State University
Sadhana Puntambekar, University of Wisconsin, Madison

S3.1.4 Middle School Student Understanding of Wind
Eunmi Lee, Dominican University

S3.1.5 "A Day Is When I Play:" How 1st-8th Grade Students Understand the Word "Day"
Danielle B. Harlow, University of California at Santa Barbara
Lauren H. Swanson, University of California at Santa Barbara
Adam Truxler, University of California at Santa Barbara

S3.1.6 An Analysis of Science Instruction in the Fifth-Grade Science Classroom: Investigating Activity-Based Instruction with Student-Generated Discussion
Julie E. Vowell, University of Houston

S3.1.7 Examining the Impact of Evolution Instruction on Understanding and Acceptance of Evolutionary Theory and the Nature of Relationships among Understanding, Acceptance, Thinking Dispositions, and Religiosity
Hasan Deniz, University of Nevada Las Vegas
Chris S. Sefcheck, Coronado High School Las Vegas

S3.1.8 Assessing Fifth Grade Student's Ability to Determine the Status of Their Own Conception and Investigating the Effect of Cooperative Learning on Achievement and Alternative Conception
Donna M. Lewis
David Treagust, Curtin University

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S3.2 Poster Session
3:00pm – 4:30pm, Royal Ballroom

S3.2.1 Form and Structure of Chinese Characters and Children's Understanding of Science
May Hung, May Cheng, The Hong Kong Institute of Education

S3.2.2 Inquiry-Based School Science: University, School and Scientists Partnerships
Lucy Avraamidou, University of Nicosia
Maria Evagorou, Kings College London

S3.2.3 NSF-Graduate Fellows and Teachers Engage in Interdisciplinary Learning
Jennifer Wilhelm, Texas Tech University
Darrellee Clem, Texas Tech University
Xiaobo She, Texas Tech University

S3.2.4 Exploring Cognitive Engagement in Students Learning Evolution in a Project-Based Approach
Kristin L. Cook, Indiana University
Gayle A. Buck, Indiana University
Meredith Park-Rogers, Indiana University

S3.2.5 Small Group Science Talk in a Design-Based Classroom: An Exploratory Study
Anushree Bopardikar, University of Wisconsin-Madison
Sarah A. Sullivan, University of Wisconsin-Madison
Sadhana Puntambekar, University of Wisconsin-Madison

S3.2.6 Understanding Teacher Facilitation of Small Group Interactions in Design-Based Science Classes
Katherine D. Knight, University of Wisconsin-Madison
Sadhana Puntambekar, University of Wisconsin-Madison

S3.2.7 What is Technology? A Theoretical Framework for Investigating Student Conceptions about the Nature of Technology
Nicole DiGironimo, University of Delaware

S3.2.8 Exploring English Language Learners' Perspectives of the Most Helpful Science Activity Centered on Animal Life Cycles
Lisa M. Algee, University of California, Santa Cruz

S3.2.9 Employing a Mixed Methods Approach to Study Urban Science Learning Environments
Gillian U. Bayne, Lehman College of the City University of New York

S3.2.10 Promoting Argumentation within Elementary Science Inquiry
Elizabeth Redman, University of California, Los Angeles
Noel Enyedy, University of California, Los Angeles
William Sandoval, University of California, Los Angeles

S3.2.11 The Development of PCK in Science Teachers: Classroom Enactment as a Prompt for Reflection
Cheryl Ann Madeira, University of Toronto
James D. Slotta, University of Toronto

S3.2.12 A Study of 7th Graders' Critical Thinking Ability and Attitudes about Genetic News
Wen-Hua Chang, National Taiwan Normal University
Katherine Hsieh, National Taiwan Normal University
Pei-Ying Tsai, National Changhua University of Education

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies
S3.3 Poster Session
3:00pm – 4:30pm, Royal Ballroom

S3.3.1 A Pedagogical Framework for Teaching Science as Inquiry in a Singapore Primary School
Chew Leng Poon, Nanyang Technological University, Singapore
Yew Jin Lee, Nanyang Technological University, Singapore
Aik Ling Tan, Nanyang Technological University, Singapore
Shirley Lim, Nanyang Technological University, Singapore

S3.3.2 Explanations on Sense Organs and Nervous System: A Content Analysis of Primary School Textbooks
Adrianna Gómez, Unidad Monterrey, Cinvestav
Agustin Adúriz-Bravo, Universidad de Buenos Aires
Maria Teresa Guerra, Unidad Monterrey, Cinvestav
Anna Marba, Universitat Autònoma de Barcelona

S3.3.3 The Use of Hands-On Science Materials and Standardized Science Test Scores
Scott A. Ashmann, University of Wisconsin-Green Bay

S3.3.4 Combining Inquiry and Strategies for English as an Additional Language (EAL) Learners to Promote Use of Science Language by Kindergarten Students
Liesl M. Hohenshell, University of Wisconsin-Whitewater
Lacy Behringer, Lincoln Elementary School

S3.3.5 How Explicit Reflective Instruction Fosters Early Elementary Students' Understandings of Nature of Science
Khemmawadee Pongsanon, Indiana University
Cassie Quigley, Indiana University

S3.3.6 Cooperative Learning in Science Inquiries: Supporting Students' Science Thinking and Social Interaction
Winnie Wing-mui So, The Hong Kong Institute of Education

S3.3.7 Exploring Korean Children's Imaginary Science Drawings: A Case of Science-art Integration
Kongju Mun
Sung-Won Kim, Ewha University, Korea

S3.3.8 Children's Non-Fiction Science Trade Books and Read-Alouds: Their Impact on Science Learning
Dawn L. Sutherland, University of Winnipeg
Donna Haydey, University of Winnipeg

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies
S3.4 Poster Session
3:00pm – 4:30pm, Terrace

S3.4.1 Examining Changes in Teachers' Assessment Practices & Knowledge Development During Technology Enhanced Instruction
Keisha Varma, University of California - Berkeley
Erika Tate, University of California - Berkeley

S3.4.2 Modeling the Epistemic Activity of High School Students in a Physics Laboratory Activity Using Motion Sensors
Ricardo L. De la Garza, Unidad Monterrey Cinvestav
Adrianna Gómez, Unidad Monterrey Cinvestav

S3.4.3 Teachers' Perspectives on an Inquiry-based Evolution Unit
Lara B. Pacifici, University of Georgia
Norman Thomson, University of Georgia

S3.4.4 Constructing Pedagogical Content Knowledge: Adopting Argumentation in the Context of a Grade Nine Unit on Heat
Karen C. Goodnough, Memorial University of Newfoundland
Pamela Osmond, Memorial University of Newfoundland

S3.4.5 Examining Lower Secondary Science (LSS Year 7-9) Teachers' Conceptions of Teaching and Learning Science
Roslena Johari, University of Nottingham, United Kingdom

S3.4.6 Changes in the Scientific Literacy of Middle Years Students, in Relation to Biotechnology, After Completing an Inquiry-Based Unit
Harry Kanasa, The University of Queensland
Kim Nichols, The University of Queensland

S3.4.7 Design, Development and Iterative Refinement of a Module on Electromagnetic Properties of Materials for High School Students
Costas P. Constantinou, University of Cyprus
Y. Hadjidemetriou, University of Cyprus
L. Fakiolas, University of Cyprus
Y. Karmiotis, University of Cyprus

S3.4.8 Investigating the Impact of Teachers' Implementation Practices on Academic Achievement in Science during a Long-Term Professional Development Program
Murat Gunel, Ataturk University
Brian Hand, University of Iowa

S3.4.9 Applications of Photonics in NYC High Schools? A Hands-On Professional Development Workshop to Increase Teachers' Content Knowledge, Self-Efficacy, and Use of Inquiry Methods
Cheryl Bluestone, Queensborough Community College/CUNY
Paul Marchese, Queensborough Community College/CUNY
Deborah Hecht, CUNY
Catarina LaFata, CUNY

S3.4.10 The Relationship between Mathematics Achievement and Chemistry Achievement in a Low-Performing, Urban High School
Susan L. Hunt, Long Beach Unified School District
Susan Gomez-Zwiep, California State University Long Beach

S3.4.11 What Happens When Students Work In Groups?
Juanita Jo Matkins, College of William & Mary
Gail B. Hardinge, College of William & Mary
Nancy W. West, College of William & Mary
John A. McLaughlin, McLaughlin Associates

S3.4.12 Understanding How Students Solve Novel Design Challenges
Xornam Apedoe, University of San Francisco
Christian D. Schunn, University of Pittsburgh

S3.4.13 Developmental Tasks, Stereotypes and Motivational Learning Environments in German Science Lessons
Nina Bertels, Freie Universität Berlin
Claus Bolte, Freie Universität Berlin

S3.4.14 Biotechnology Pedagogical Knowledge through Mortimer's Conceptual Profile
Andoni Garritz, Universidad Nacional Autonoma de Mexico
Patricia Velazquez, Universidad Nacional Autonoma de Mexico

S3.4.15 An Analysis of the Benefits Using Different forms of Formative Assessment Strategies
Liling Chao, National Changhua University of Education
Jui Feng Wang, National Changhua University of Education
Wei Lung Wang, National Changhua University of Education
Chiung Fen Yen, Providence University, Taiwan
Fan Shing Chen, National Changhua University of Education
Tzu Hua Wang, Providence University, Taiwan

S3.4.16 Defining and Measuring Science Teachers' Conceptual Ecology for Assessment of Students' Learning in Science
Mehmet Aydeniz, The University of Tennessee, Knoxville
Lei Wang, Beijing Normal University

S3.4.17 Student Whiteboards: A Window on Thinking and Learning
Colleen Megowan-Romanowicz, Arizona State University

S3.4.18 Differences in Reform-Based Classroom Practices of Novice Teachers in Block and Traditional Schedules
Allison L. Kirchhoff, University of Minnesota
Gillian Roehrig, University of Minnesota
Julie Luft, Arizona State University

S3.4.19 Towards a Paradigm Shift in the Teacher's Role in Science Education – Teachers' Readiness for Change
Anne Laius, University of Tartu
Miia Rannikmäe, University of Tartu

S3.4.20 A Beginning Secondary Science Teacher who Works with English Language Learners: Looking at Instruction and Pedagogical Content Knowledge
Irasema Ortega, Arizona State University
Sissy Wong, Arizona State University
Jonah Firestone, Arizona State University
Julie Luft, Arizona State University

Strand 5: College Science Teaching and Learning (Grades 13-20)

S3.5 Poster Session
3:00pm – 4:30pm, Royal Ballroom

S3.5.1 The Relationships between College Students' Epistemological Beliefs of Science and Conceptions of Learning Science
Jyh Chong Liang, Chin Min Institute of Technology
Chin Chung Tsai, National Taiwan University of Science and Technology
Min Hsien Lee, National Taiwan Normal University
Szu Hsien Wu, School of Medicine National Yang-Min

S3.5.2 College Students' Domain-Specific Epistemological Beliefs of Sciences: A Comparison of Students' Conception of Biology and Physics
Wen-Yu Lee, National Taiwan University of Science and Technology
Chin-Chung Tsai, National Taiwan University of Science and Technology

S3.5.3 Team Teaching of a Prep Course for Teaching Assistants
Gili Marbach-Ad, University of Maryland
Patty Shields, University of Maryland
Brett Kent, University of Maryland
Katerina V. Thompson, University of Maryland
William J. Higgins, University of Maryland

S3.5.4 Authentic Science Research Experiences for Undergraduates: Participation Patterns of Students Underrepresented in the Sciences
Troy D. Sadler, University of Florida
Luis Ponjuan, University of Florida
Lyle McKinney, University of Florida
Laura Waltrip, University of Florida

S3.5.5 Effects of Problem-Based Learning on Students' Learning Satisfaction, Motivation, and Conceptual Change in a College Biology Course
Moon-Heum Cho, Indiana University - Purdue University
Deanna M. Lankford, University of Missouri
Daniel J. Wescott, University of Missouri

S3.5.6 The Complex Nature of Student Reading Questions in a Large-Lecture Biochemistry Course
Erika G. Offerdahl, North Dakota State University

S3.5.7 Social Supports for Inquiry Learning with Virtual Laboratories: Evidence from two studies.
Eva Toth, Duquesne University

S3.5.8 Using College Math Placement Exam Scores to Predict Achievement in Introductory Biology
Melissa Schen, Wright State University
Kathy Koenig, Wright State University
Christopher Schooley, Wright State University

S3.5.9 Introduction to Inquiry and Traditional Curricula: The Implications of Content Differences in Preservice Middle School Science Students
Benjamin P. Heroux, University of Cincinnati
Catherine M. Koehler, University of Cincinnati
Jonathan Breiner, University of Cincinnati

Strand 6: Science Learning in Informal Contexts

S3.6 Poster Session
3:00pm – 4:30pm, Royal Ballroom

S3.6.1 Multiple Perspectives of Out-of-School Learning in Various Institutions
Orly Morag, Technion
Tali Tal, Technion

S3.6.2 Shhh… Don't Use the 'A' Word: Embedded Assessments of Youth Learning in Informal Learning Environments
Melissa Koch, SRI International
William R. Penuel, SRI International
Torie Gorges, SRI International
Geneva Haertel, SRI International

S3.6.3 Blood, Sweat, and Gears: How the FIRST Robotics Competition Effects Attitudes toward Science
Anita G. Welch, North Dakota State University

S3.6.4 Silent Invasion: Investigating Oregonians' Self-Reported Awareness, Understanding and Behaviors toward Invasive Species
Lynn D. Dierking, Oregon State University
Samuel Chan, Oregon State University
Gwenn Kubeck, Oregon State University
Joseph Cone, Oregon State University

S3.6.5 Comparing Out-of-School Research and Practice: Teachers' Field Trip Strategies on a Self-Guided Aquarium Visit
Bryan M. Rebar, Oregon State University

S3.6.6 Implementing a Scientists in Schools Pilot Project: Issues and Outcomes
Leonie J. Rennie, Curtin University of Technology
Christine Howitt, Curtin University of Technology

S3.6.7 Judging [at] a Science Fair: Dilemmas for Judges and Organizers
John L. Bencze, University of Toronto
Gervase M. Bowen, Mount Saint Vincent University
Nicole Arsenault, Mount Saint Vincent University

S3.6.8 Timeline and Time Scale Cognition Experiments for a Geological Interpretative Exhibit at Grand Canyon
Steven Semken, Arizona State University
Jeff Dodick, The Hebrew University of Jerusalem, Israel
Orna Ben-David, The Hebrew University of Jerusalem, Israel
Monica Pineda, Arizona State University
Nievita Bueno Watts, Arizona State University
Cheryl Alvarado, Arizona State University
Karl Karlstrom, University of New Mexico

S3.6.9 Using Novel Qualitative Methods for Studying Family Free-Choice Learning at Informal Astronomy Observing Events
Matthew Wenger, University of Arizona
Kathy Carter, University of Arizona
Christopher Harris, University of Arizona

S3.6.10 Teaching Science in the City: Designing Pre-Service and In-Service Science Teacher Education
Maria S. Rivera Maulucci, Columbia University

S3.6.11 Science-Related Identity Development in Science Center Floor Staff
Jennifer D. Adams, Brooklyn College-CUNY
Preeti Gupta, New York Hall of Science

Strand 7: Pre-service Science Teacher Education

S3.7 Poster Session
3:00pm – 4:30pm, Regal

S3.7.1 Preservice Elementary Teachers' Ability to Learn How to Teaching Science from Instructional Materials: A Case Study of Japan
Etsuji Yamaguchi, University of Miyazaki, Japan
Shigenori Inagaki, Kobe University, Japan
Tomoyuki Nogami, Kobe University, Japan

S3.7.2 Working in the Trenches: An Analysis of Induction and Post-Induction Science Teachers' Instructional Beliefs and Practices and the Links to their Pre-Service Preparation
John W. Tillotson, Syracuse University
Monica J. Young, Syracuse University
Paul Preczewski, Syracuse University
Robin L. Jones, Syracuse University

S3.7.3 Examining Relationships between Expert and Pre-service Teachers at a Summer Science Camp
Shehzad Bhojani, Mt. San Antonio College
Laura Henriques, California State University at Long Beach

S3.7.4 Preservice Science Teachers' Informal Reasoning Quality: An Analysis across Multiple Socio-scientific Issues
Mustafa S. Topcu, Yüzüncü Yýl University
Troy D. Sadler, University of Florida

S3.7.5 Preservice Elementary Teachers' Diversity Beliefs: Influence of Science Methods Course on Personal and Professional Beliefs about Diversity
Adrienne Gifford, University of Minnesota
Bhaskar Upadhyay, University of Minnesota
Brian Fortney, University of Texas at Austin

S3.7.6 Into the Wild: Navigating a New Frontier for Pre-Service Science Teacher Education
Laura J. Saxman, The Center For Advanced Study in Education (CASE)
Preeti Gupta, The New York Hall of Science

S3.7.7 STEM Career-Changers in Their First Years of Teaching: A Follow-Up Study
Carol C. Johnston, Mount Saint Marys College
Jeanne M. Grier, California State University Channel Islands

S3.7.8 Enhancing Reform-based Pre-Service Elementary Science Teaching Practices through Out-of-School Time Teaching
Tina J. Cartwright, Marshall University
Katie McDilda, Marshall University
Jennifer Jackson, Marshall University
Michael Corrigan, Marshall University

S3.7.9 The Development and Utilization of a Standards-Based Instrument to Evaluate the Perceived Preparedness of Science and Mathematics Teachers in an Alternative Certification Program
William J. Boone, Miami University
Sandra K. Abell, University of Missouri
Mark J. Volkmann, University of Missouri
Fran Arbaugh, University of Missouri
John K. Lannin, University of Missouri

S3.7.10 Pre-service Teachers' Synthetic View on Darwinism and Lamarckism
Minsu Ha, Korea National University of Education
Heeyoung Cha, Korea National University of Education

S3.7.11 How Many Courses Does It Take for Preservice Teachers to Understand the Essence of NOS and Inquiry? The Count is Ticking
Catherine M. Koehler, University of Cincinnati
Benjamin Heroux, University of Cincinnati
Jonathan Breiner, University of Cincinnati

S3.7.12 Identifying and Meeting the Challenges of Developing Reform-Oriented Elementary Science Teachers
Moses K. Ochanji, California State University San Marcos
Thomas J. Diana, Utica College

S3.7.13 Teaching Preservice Teachers to Use Learning Theory to Make Instructional Decisions
Joanne K. Olson, Iowa State University
Michael P. Clough, Iowa State University
Crystal N. Bruxvoort, Calvin College
Andrea J. Vande Haar, University of Northern Iowa
Kimberly A. Penning, Iowa State University

S3.7.14 Scientists to Teachers: The Role of Epistemology in Lesson Plans of Career Switchers
Erin E. Peters, George Mason University
Brad Rankin, George Mason University

Strand 8: In-service Science Teacher Education

S3.8 Poster Session
3:00pm – 4:30pm, Royal Ballroom

S3.8.1 Science Teachers' Knowledge of the Water System
Younkyeong Nam, University of Minnesota
Fred Finley, University of Minnesota
Gillian Roehrig, University of Minnesota

S3.8.2 Teacher-Student Interaction: The Overlooked Dimension of Inquiry-Based Professional Development
Alandeom W. Oliveira, University at Albany, SUNY

S3.8.3 Impact of an Intensive Renewable Energy Course on the Science Self-Efficacy and Content Knowledge of K-8 Teachers
Margaret D. Nolan, Boston University
Donald DeRosa, Boston University
Andrew Duffy, Boston University
Russell Faux, Davis Square Research Associates
Peter Garik, Boston University
Bennett Goldberg, Boston University

S3.8.4 Content Knowledge and Efficacy
Helene Sørensen, Århus University
Robert H. Evans, University of Copenhagen
Annemarie M. Andersen, Århus University

S3.8.5 Supporting Senior High Science Data Logging Integration: the Identification and Support from Outsider Communities
Ronald J. MacDonald, University of Prince Edward Island
Angela F. Larter, University of Prince Edward Island
Jeff Carragher, Eastern School District
Chris Higginbotham, Western School Board
Lisa Ling, Eastern School District
Ryan McAleer, Western School Board
Dave Ramsay, Western School Board
Steven Wynne, Eastern School District

S3.8.6 School, Teacher, and Student Factors Impacting Students' Science Achievement
Debbie K. Jackson, Cleveland State University
Joanne E. Goodell, Cleveland State University
Sally Mascia, Cleveland Heights-University Heights City School District

S3.8.7 Science Teachers and Scientific Argumentation: Trends in Practice and Beliefs
Victor Sampson, Florida State University

S3.8.8 CASES: A Professional Development Experience for Enhancing Content and Supporting Inquiry-Based Science Teaching in Elementary Classrooms
Michelle L. Klosterman, University of Florida
Rose M. Pringle, University of Florida
Lynda Hayes, University of Florida
Katie Milton, University of Florida

S3.8.9 Exploring Written Discourse in e-Mentoring: When a First-Year Science Teacher at a Charter School Met an Expert Mentor in a Virtual World
EunJin Bang, Iowa State University
Julie Luft, Arizona State University

S3.8.10 What Can Scientists Do? Assessing K-12 Science Teachers' Educational Product Needs
Stephanie J. Slater, University of Wyoming
Timothy F. Slater, University of Wyoming

S3.8.11 Zones of Influence: Creating Professional Development Opportunities for Instructors of Informal Science Education
Rashmi Kumar, University of Pennsylvania
Susan Yoon, University of Pennsylvania
Melissa Chessler, Independent Consultant

Strand 9: Reflective Practice

S3.9 Poster Session
3:00pm – 4:30pm, Royal Ballroom

S3.9.1 Classroom Action Research as Professional Development in Science Education
Margilee P. Hilson, Columbus City Schools, Ohio
Kathy Cabe Trundle, The Ohio State University
Donna Farland-Smith, The Ohio State University

S3.9.2 Subject-Related Mentoring in Biology Teacher Education
Doris Elster, University of Kiel

S3.9.3 Pre-Service Elementary Teachers, Date-Related Science Practices, And Socioscientific Issues
Nicole Beeman-Cadwallader, Indiana University
Gayle A. Buck, Indiana University

S3.9.4 Using an Action Research Framework to Broaden Teacher Candidates' Views of Critical Multicultural Science Education: Insights and Challenges
Azza Sharkawy

S3.9.5 Secondary Science Teachers' Collaborative Reflections on Sharing Best Practices
Connie F.C. Woytowich, University at Albany

Strand 10: Curriculum, Evaluation, and Assessment

S3.10 Poster Session
3:00pm – 4:30pm, Royal Ballroom

S3.10.1 The Development of Argumentation Skills and Content Knowledge of Intermolecular Forces Using a Nanoscience Context
Harold B. Short, University of Michigan
Morten Lundsgaard, University of Michigan
Joseph Krajcik, University of Michigan

S3.10.2 The Interaction of Assessment Format and Sex in Assessing Knowledge Structure Coherence for the Understanding of Force Concepts
Sharon P. Schleigh, East Carolina University

S3.10.3 Wallpaper or Instructional Aids: A Preliminary Case Study of Science Teachers' Perceptions and Use of Wall-Posters in the Classroom
Michael Hubenthal, IRIS Consortium

S3.10.4 Research and Development of an Educative Teachers' Guide for Explicit Nature of Science Curriculum Materials
Shu-Fen Lin, National Chiao Tung University
Sang-Chong Lieu, National Hualien University of Education
Wen-Hua Chang, National Taiwan Normal University
Wen-Ling Chen, De-Gau Elementary School
Sufen Chen, National Taiwan University of Science and Technology
Mao-Tsai Huang, National Academy of Educational Research

S3.10.5 Towards the Use of Concept Maps in Large-Scale Science Assessments: Exploring the Efficiency of Two Scoring Methods
Maria Araceli Ruiz-Primo, University of Colorado Denver
Heidi Iverson, University of Colorado at Boulder
Yue Yin, University of Illinois, Chicago

S3.10.6 Problem Solving Competencies in Chemistry
Rüdiger Tiemann, Humboldt-University at Berlin
Jenny Koppelt, Humboldt-University at Berlin

S3.10.7 Examination of Science Process Skills in New Elementary Science and Technology Curriculum
Jale Cakiroglu, Middle East Technical University
Sevgi Aydin, Middle East Technical University

S3.10.8 Pathways to Inquiry - Earth Science: Online Tools to Strengthen Classroom Understanding and Integration of Science Inquiry Skills
Pamela B. Blanchard, Louisiana State University
Yiping Lou, Louisiana State University

S3.10.9 Hypothetical Learning Trajectory for Measurement: A Multidisciplinary Study
Jennifer Schiller, State University of New York at Buffalo
Nosisi Feza, State University of New York at Buffalo
Joseph Johnson, State University of New York at Buffalo
Julie Sarama, State University of New York at Buffalo
Douglas H. Clements, State University of New York at Buffalo
Jeffrey Barrett, Illinois State University

S3.10.10 Science Teachers' Perceptions about New Science and Technology Curriculum
Sevgi Kingir, Selcuk University

S3.10.11 Curriculum Revision: Exploring Teachers' Views and Their Affective Factors on New Science Curriculum
Yi-Ting Cheng, National Changhua University of Education
Wen-Yu Chang, National Changhua University of Education
Huey-Por Chang, National Changhua University of Education
Jun-Yi Chen, National Chiayi University

Strand 11: Cultural, Social, and Gender Issues

S3.11 Poster Session
3:00pm – 4:30pm, Terrace

S3.11.1 Teaching Science to Immigrant Students with Culturally-Sensitive Pedagogy: Empowering
Language Minority Students
Bhaskar Upadhyay, University of Minnesota

S3.11.2 A 7-12 Urban Science Fair: Patterns of Participation and Category Selection by Age and Gender
Kathleen A. Fadigan, Penn State University

S3.11.3 Cultural Food Days and Growing Gardens?: Pre-service Elementary Teacher Emerging Beliefs and Knowledge about Contextualizing Science Instruction for Diversity and Social Justice
Sara E. Tolbert, University of California, Santa Cruz

S3.11.4 Establishing Access to Science through the Back Door: What are Elementary Teachers' Perspectives on the Integration of English Language Development and Science instruction?
Susan Gomez-Zwiep, CSU Long Beach
William J. Straits, CSU Long Beach

S3.11.5 Using Curriculum to Close Achievement Gaps
Susan M. Kowalski, BSCS Center for Curriculum Development
Molly A. M. Stuhlsatz, BSCS Center for Research and Evaluation
Joseph A. Taylor, BSCS Center for Research and Evaluation

S3.11.6 Cultural Diversity in the Classroom: Salish Kootenai Students' Perceptions of Ecosystem Relationships
Rose E. Honey, Harvard University
Tina A. Grotzer, Harvard University

S3.11.7 Educator Impacts on the Self-Efficacy Beliefs of Women In Chemistry: A Case Study
Megan L. Grunert, Purdue University
George M. Bodner, Purdue University

S3.11.8 Fictive Kinship as it Affects Resiliency and Perseverance of Inner-City High School Students in a College Physics Lab
Konstantinos Alexakos, Brooklyn College, CUNY
Jayson K. Jones

S3.11.9 Charting the Pipeline: Identifying the Critical Life Elements in the Development of Successful African American Scientists, Engineers, and Mathematicians
Brian A. Williams, Georgia State University

S3.11.10 Prospective STEM Teachers' Assumptions about Low Income or Poor Students and Their Families
Athena R. Ganchorre, University of Arizona
Debra Tomanek, University of Arizona

S3.11.11 Gender Issues in Science Education: Beyond Gaps to Strategies for Action
Patricia K. Freitag, Education Consulting

S3.11.12 Examining Adolescent Girls' Engagement in Problem-Based Science Instruction
Gayle Buck, Indiana University
Nicole Beeman-Cadwallader, Indiana University
Amy Trauth-Nare, Indiana University

S3.11.13 A Case Study on a Socio-Scientific Curriculum Facilitating Undergraduates NOS Conceptualizations
Kelly A. Schalk, University of Maryland

S3.11.14 There Must Be: Differences between Estonian and Russian Students'
Imbi Henno, Tallinn University
Priit Reiska, Tallinn University

S3.11.15 Facilitating Science Understanding and Fluency among Hispanic ELL Students: Strategies, Explorations, and New Directions
Ann Cavallo, The University of Texas at Arlington
Patricia Gomez, The University of Texas at Arlington

S3.11.16 The Practice of Science Inquiry within a Small Group of Hmong Youth
Michele J. Hollingsworth Koomen, Gustavus Adolphus College

S3.11.17 The Influence of Departmental Climate on Female Engineering Professors
Monica J. Young, Syracuse University
John W. Tillotson, Syracuse University

S3.11.18 Korean Elementary School Students' Views about Nature: An Interpretive Worldview Study
Jeongae Won, Daejeon Meabong Elementary School, Korea
Seonghey Paik, Korea National University of Education, Korea
William W. Cobern, Western Michigan University

Strand 12: Educational Technology

S3.12 Poster Session
3:00pm – 4:30pm, Royal Ballroom

S3.12.1 Learning the Effects of Drug Abuse on the Brain by Virtual Exhibit and Video Games in Museum
Meng-Tzu Cheng, NC State University
Leonard Annetta, NC State University
Elizabeth Folta, NC State University

S3.12.2 Examining How Teachers Use Web 2.0 Technologies in Science Lessons to Promote Higher Order Thinking Skills
Gail D. Chittleborough, Deakin University Victoria, Australia
Wendy Jobling, Deakin University Victoria, Australia
Filocha M. Haslam, Deakin University Victoria, Australia
Peter Hubber, Deakin University Victoria, Australia
Gerard Calnin, Association of Independent Schools Victoria, Australia

S3.12.3 Technology Use and Students' Perceptions in Science and Art Courses: Has There Been Any Change Lately?
Rana M. Tamim, Concordia University
Gretchen Lowwerison, Concordia University
Richard F. Schmid, Concordia University
Robert M. Bernard

S3.12.4 Growth in Teacher Self-Efficacy through Participation in a High-Tech Instructional Design Community
Colleen Megowan-Romanowicz, Arizona State University
Sibel Uysal, Arizona State University
David A. Birchfield, Arizona State University

S3.12.5 Gender-Related Beliefs of Turkish Female Science Teachers and Their Effect on Their Interactions with Female and Male Students
Sibel Uysal, Arizona State University
Eric Margolis, Arizona State University

S3.12.6 Teaching Science Methods Online: Addressing the Online Paradigm and Considerations for Optimizing Online Instruction
Charles B. Hutchison, University of North Carolina at Charlotte

S3.12.7 Challenges using Multimedia Integrated within a Science Curriculum using a Classroom-Centered Design Approach
Rebecca R. Deutscher, UC Berkeley

S3.12.8 Students' Perceptions of Online Learning Environments
Michelle Cook, Clemson University
Leonard A. Annetta, North Carolina State University
Daniel L. Dickerson, Old Dominion University
James Minogue, North Carolina State University

S3.12.9 Impact of Othello Game Through E-Learning on Fifth Graders' Creativity and Problem-Solving Abilities
Wanchu Huang, Taipei Municipal University of Education
Wen-Hsien Lin, SinPu Elementary School

S3.12.10 Learning Secondary Science Using Geospatial Technology: Understanding Student Experiences and Perceptions
Clare K. Morgan, Hobart and William Smith Colleges
James G. MaKinster, Hobart and William Smith Colleges
Nancy M. Trautmann, Cornell University

S3.12.11 Using Simulations to Support Powerful Formative Assessments of Complex Science Learning
Edys Quellmalz, WestEd
Barbara C. Buckley, WestEd
Mike Timms, WestEd

Strand 13: History, Philosophy, and Sociology of Science

S3.13 Poster Session
3:00pm – 4:30pm, Royal Ballroom

S3.13.1 Metacognitive Underpinnings of "Nature of Science" and Implications for Science Education
Nicola Mittelsten Scheid, Queens University, Canada
Peter Chin, Queens University, Canada

S3.13.2 The Context, Accuracy and Frequency of Inclusion of Key Nature of Science Concepts in Current Secondary Level Physics Textbooks
Saeed Alsamrani, University of Arkansas
William F. McComas, University of Arkansas

S3.13.3 The Nature of the Pedagogy of the History of Science
Catherine Lange, State University of New York College at Buffalo
Josephy Zawicki, State University of New York College at Buffalo
Barbara Rascoe, Mercer University

S3.13.4 Reliabilism: An Epistemological Framework for Defining Knowledge in the Science Classroom
Samuel R. O'Dell, Jr., University of Georgia

S3.13.5 Supporting Preservice Elementary Teachers' Nature of Science Instruction
Valarie L. Akerson, Indiana University
Lisa A. Donnelly, Kent State University
Morgan Riggs, Indiana University
Jennifer Eastwood, Indiana University

S3.13.6 Connecting Nature of Science Knowledge and Content Knowledge: An Intervention Study
Erin E. Peters, George Mason University

S3.13.7 The Trouble with Scientists' Views of Nature of Science
Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign
May Jadallah, University of Illinois at Urbana-Champaign

S3.13.8 Understanding Students' Conceptions of the Nature of Science through Multiple Assessment Tools
Dana Gnesdilow, University of Wisconsin- Madison
Sarah A. Sullivan, University of Wisconsin- Madison
Anushree Bopardikar, University of Wisconsin- Madison
Sadhana Puntambekar, University of Wisconsin- Madison

S3.13.9 Rethinking Science Literacy: Critical Tales from the Classroom and Field
Kevin Carr, Pacific University

Strand 14: Environmental Education

S3.14 Poster Session
3:00pm – 4:30pm, Imperial

S3.14.1 Teachers Experiences in Environmental Education: Negotiating the Complexities
Michael Tan, University of Toronto
Erminia Pedretti, University of Toronto
Gabriel Ayyavoo, University of Toronto
Katherine Bellomo, University of Toronto

S3.14.2 Survey of Students' Environmental Attitudes and Behaviors in High School Environmental Science Courses
Erica N. Blatt, University of New Hampshire
Eleanor Abrams, University of New Hampshire

S3.14.3 Bringing Citizens to Natural Areas: Motivations and Barriers to Participation in Citizen Science
Oksana Bartosh, University of British Columbia
Jolie Mayer-Smith, University of British Columbia
Linda Peterat, University of British Columbia

S3.14.4 Measuring Students' Implicit Attitudes toward Environmental Protection
Tzu-Yu Chou, National Taiwan Normal University
Hao-Chuan Wang, Cornell University
Ting-Kuang Yeh, National Taiwan Normal University
Chun-Yen Chang, National Taiwan Normal University

S3.14.5 The Effect of Demographic Variables on Preservice Teachers' Environmental Literacy
Ozgul Yilmaz Tuzun, Middle East Technical University
Gokhan Ozturk, Middle East Technical University
Gaye Teksoz Tuncer, Middle East Technical University

S3.14.6 Children's Worldviews from China, Singapore and the United States: Implications for Research, Teaching and Learning in Science and Science Education
Bryan S. Wee, University of Colorado
Ya-Wen Chang, University of Colorado
Austine Luce, University of Colorado

S3.14.7 Elementary Teachers' Science Teaching for Environmental Decision-making
Cory T. Forbes, University of Michigan
Michaela Zint, University of Michigan

S3.14.8 Place-Based Learning Environments and Teacher Development
Carlos Ormond, Simon Fraser University
David B. Zandvliet, Simon Fraser University

S3.14.9 Design Template for Ecology Professional Development
Claudia Khourey-Bowers, Kent State University
Donald Gerbig, Kent State University

S3.14.10 High School Students' Awareness and Misconceptions Related to Solar Cells
Padmini Kishore, La Mirada High School, CA
James Kisiel, California State University, Long Beach

S3.14.11 Undergraduate Students' Attitudes toward Biodiversity and Biodiversity Curriculum
Yu-Teh Lin, National Taiwan University
Hui-Ju Huang, California State University Sacramento

S3.14.12 Denial and Socio-scientific Issues: Understanding Public Resistance

G. Michael Bowen, Mount Saint Vincent University
Valerie Rodger, Dalhousie University

S3.14.13 Emphasis Given to Climate Change in State Science Standards: Are States Warming Up to the Science?

Barry W. Golden, Florida State University
Yavuz Y. Saka, Florida State University

S3.14.14 Environmental Behavior Change: Influencing Learner Behavior through Environmental Education

Rita A. Hagevik, The University of Tennessee
Carolyn D. Reilly-Sheehan, The University of Tennessee

Strand 15: Policy

S3.15 Poster Session
3:00pm – 4:30pm, Royal Ballroom

S3.15.1 Experts' Perception of Challenges and Opportunities in Science Education in Africa: An Agenda to Accelerate Catch-Up

Peter A. Okebukola, Crawford University, Nigeria
Tunde Owolabi, Lagos State University, Nigeria
Irene U. Osisioma, California State University

S3.15.2 New York State Regents Examinations: Their Evolution Related to the Current Social Context of Schools

Connie F.C. Woytowich, University at Albany/Colonie Central High School

S3.15.3 Turbulence: The Dynamic Interplay of Factors Which Influence Urban Educational Reform

Carla C. Johnson, University of Cincinnati

S3.15.4 Leaving Science Behind: A Case Study of Teaching Science in a Rural School amid High Stakes Testing

Georgia Hodges, University of Georgia
Deborah Tippins, University of Georgia

S3.15.5 Secondary Science Teachers' Employment System in Asian Regions

Young-Shin Park, Chosun University, Korea
BaoHui Zhang, Nanyang Technological University, Singapore
Hsiao-Lin Tuan, National Changhua University of Education, Taiwan
Yoshisuke Kumano, Shizuoka University, Japan
Xinkai Luo, Guangxi normal University, China Mainland

Concurrent Session #4
4:45pm – 6:15pm

Presidential Invited Session
4:45pm – 6:15pm, Grand Ballroom D

S4.1 Simple Participatory Accelerated Research Kick-Offs (SPARK) Talks

The session will feature numerous speakers on a variety of topics, each given only 5 minutes to present their research findings. These 5 minute research presentations are designed as kick off sessions that will be followed up with dinner with the presenter and colleagues like you who are interested in engaging in interesting conversation on the topic. Each participant is responsible for his/her own meal costs.

Presider: Kate Popejoy, University of North Carolina, Charlotte
Presenters: Eleanor Abrams, University of New Hampshire
Len Annetta, North Carolina State University
Bill Boone, Miami University, Ohio
Gayle Buck, Indiana University
George Glasson, Virginia Tech
Tamara Holmund Nelson, Washington State University, Vancouver
Pernilla Nilsson, Halmstad University, Sweden
Brian Wilson, Georgia State University

International Committee Sponsored Session
S4.2 Symposium: From Teaching to 'Know' to Learning to 'Think' in Science Education
4:45pm – 6:15pm, Grand Ballroom E

Presider: Mei-Hung Chiu, National Taiwan Normal University
Discussant: Jonathan Osborne, Stanford University
Presenters: Reinders Duit, Leibniz Institute for Science Education, Germany
Helge Strömdahl, Linköeping University, Sweden
Uri Zoller, University of Haifa, Israel
William C. Kyle, Jr., University of Missouri-St. Louis
Mei-Hung Chiu, National Taiwan Normal University
Chin-Cheng Chou, HungKuang University, Taiwan
Hui-Jung Chen, National Taiwan Normal University
Chun-Feng Tsai, National Taiwan Normal University

Strand 1: Science Learning, Understanding and Conceptual Change

S4.3 SC-Paper Set: Understanding Physical Concepts
4:45pm – 6:15pm, Grand Ballroom F

Presider: Kathleen Fisher, Center for Research in Mathematics and Science Education

S4.3.1 Teaching for Understanding in a Prescribed Physics Curriculum: A Comparison of Learning Outcomes in Conceptual Change and Traditional Classrooms

Richard F. Gunstone, Monash University
Pamela J. Mulhall, University of Melbourne

S4.3.2 Do Structure Maps Facilitate Expert-Like Problem Solving Strategies In Physics?

Frances A. Mateycik, Kansas State University
N. Sanjay Rebello, Kansas State University
David H. Jonassen, Kansas State University

S4.3.3 Analyzing Differences and Similarities in Students' Knowledge Structure Coherence and Understanding of Force

Douglas B. Clark, Arizona State University
Cynthia M. DAngelo, Arizona State University
Sharon P. Schleigh, East Carolina University

Strand 1: Science Learning, Understanding and Conceptual Change

S4.4 Symposium: Collaborations between Scientists and Science Educators: The Grand Challenges and Great Opportunities of the Centers for Ocean Education Excellence (COSEE)
4:45pm – 6:15pm, Grand Ballroom G

Presider: Ravit Golan Duncan, Rutgers University
Discussant: Gordon Kingsley, Georgia Institute of Technology
Presenters: Janice McDonnell, Rutgers University
Chankook Kim, Seoul National University
Howard Walters, Ashland University
Patricia Kwon, COSEE-West
Judy Lemus, University of Hawaii

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S4.5 SC-Paper Set: Bringing Science to the Classroom: Reasoning, Thinking, Interpretation, and Motivation
4:45pm – 6:15pm, Garden 3

Presider: Brandon Emig, Pennsylvania State University

S4.5.1 Young Children's Reasoning about Anomalous Data, Evidence and the Design of Tests: Taking Science to School in Kindergarten

Deborah C. Smith, Pennsylvania State University
Carla Zembal-Saul, Pennsylvania State University
Jessica Cowan, Grays Woods Elementary School

S4.5.2 The Effects of Constructivist Classroom Contextual Factors in a Life Science Laboratory and a Traditional Science Classroom on Elementary Students' Motivation and Learning Strategies
Andrea R. Milner, The University of Toledo
Mark A. Templin, The University of Toledo
Charlene M. Czerniak, The University of Toledo

S4.5.3 You Made Us Think, Think, Think!: An Illustration Of Questioning And Its Impact On Interaction In The Elementary Science Classroom.
Hwei Ming Wong, Nanyang Technological University
Aik Ling Tan, Nanyang Technological University

S4.5.4 Students' Interpretation on Hierarchical Graphs of the Structure of Chromosome
Chen-Yung Lin, National Taiwan Normal Univerisy
Show-Yu Lin, Aletheia University
Hsin-Yun Hsieh, National Taiwan Normal Univerisy

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies

S4.6 SC-Paper Set: Teacher Classroom Practices and Support Systems
4:45pm – 6:15pm, Garden 2
Presider: Meredith Park Rogers, Indiana University

S4.6.1 Confidence and Knowledge: Primary Teachers as In-School Science Coordinators
Eleanor A. Brodie, Sheffield Hallam University

S4.6.2 Elementary Administrators and Their Perspectives Concerning Science Education
Christina Fox Call, Brigham Young University
Nikki L. Hanegan, Brigham Young University
Sara M. Wursten, American Leadership Academy

S4.6.3 Improvising Inquiry: The Knowledge Required To Engage Students In Model-Building
Danielle B. Harlow, University of California, Santa Barbara

S4.6.4 Writing in Elementary School Science: What Types of Writing Do Teachers Have Students Produce?
Nicole J. Glen, Bridgewater State College

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies

S4.7 SC-Paper Set: Secondary Science Teacher Choices and Actions in the Science Classroom
4:45pm – 6:15pm, Salon III
Presider: Joe Engemann

S4.7.1 The Impact of Project-Based Science on High School Minority Students as Mediated by Teacher Knowledge and Practices
David E. Kanter, Temple University

S4.7.2 Tensions when Teaching Science: How a Teacher Juggles Multiple Demands of Ambitious Pedagogy in an Urban Middle School Classroom
Melissa Braaten, University of Washington
Mark Windschitl, University of Washington

S4.7.3 Development of Inquiry Skills in Middle School (Grade 7): Analysing the Effectiveness of Different Types of Instruction
Sandra Hof, Justus-Liebig-University Gießen
Jürgen Mayer, Justus-Liebig-University Gießen

S4.7.4 The Nature of Science Inquiry Facilitation in a High School Environmental Science Class
Anton S. Puvirajah, Georgia State University

Strand 5: College Science Teaching and Learning (Grades 13-20)

S4.8 SC-Paper Set: Undergraduate Research and Laboratory Experience
4:45pm – 6:15pm, Salon IV
Presider: Allison Kang, University of Washington

S4.8.1 Mentoring Takes a Village: Maximizing Undergraduate Research Potential by Building Cohesive Learning Communities
Elizabeth Berkes, UC Berkeley

S4.8.2 "It Doesn't Really Matter What the Right Answer Is:" A Case-Study on Implementing Inquiry-Based Laboratories at the University Level
Stephen B. Witzig, University of Missouri
Sandra K. Abell, University of Missouri
Frank J. Schmidt, University of Missouri

S4.8.3 Characterizing the Inquiry Experience in a Summer Undergraduate Research Program in Biotechnology and Genomics

Maya R. Patel, Cornell University
Deborah J. Trumbull, Cornell University
Elizabeth Fox, Cornell University
Barbara Crawford, Cornell University

S4.8.4 Student Perceptions of Research Intensive Science Courses at University

Roeland M. Van der Rijst, Leiden University, The Netherlands
Gerda J. Visser-Wijnveen, Leiden University, The Netherlands
Jan H. Van Driel, Leiden University, The Netherlands

Strand 6: Science Learning in Informal Contexts

S4.9 SC-Paper Set: Examining Student Science Experiences Outside of School
4:45pm – 6:15pm, Salon V

Presider: Molly E. Phipps, Science Museum of Minnesota

S4.9.1 The Nature of Science in Afterschool Science: The Development of Two New Instruments

Kelly M. Pirog, University of Massachusetts Amherst
Allan Feldman, University of Massachusetts Amherst

S4.9.2 Students, Scientists and Science in a Research Institute Classroom

Bev France, The University of Auckland
Jacquie Bay, The University of Auckland

S4.9.3 Reach for the Sky: Improving STEM Learning for Anishanabe Students

Gillian H. Roehrig, University of Minnesota
Tamara J. Moore, University of Minnesota
Stephan Carlson, University of Minnesota
Brant Miller, University of Minnesota
Selcen Guzey, University of Minnesota
Joel Donna, University of Minnesota

S4.9.4 Curricular Design to Support Students' Interactions with Their Communities

Jennifer L. Eklund, University of Michigan
Nonye Alozie, University of Michigan

Strand 7: Pre-service Science Teacher Education

S4.10 Symposium: Preparing Preservice Teachers to Integrate Inquiry Science with Language and Literacy Instruction for English Language Learners
4:45pm – 6:15pm, Salon II

Presider: Maxine McKinley, University of California, Berkeley
Discussants: David Crowther, University of Nevada, Reno
Jerome Shaw, University of California, Santa Cruz
Presenters: Trish Stoddart, University of California, Santa Cruz
Michael Stevens, California State University, Stanislaus
Marco Bravo, Santa Clara University
Jorge Solis, University of California, Berkeley
Ramon De Vega Jesus, California State University, Stanislaus
Eduardo Mosqueda, University of California, Santa Cruz

Strand 8: In-service Science Teacher Education

S4.11 SC-Paper Set: Problem-Based Learning
4:45pm – 6:15pm, Salon I

Presider: Tom McConnell, Ball State University

S4.11.1 Taking a Step towards Professional Development through Assessments in a Problem-Based Learning (PBL) Project

Sunethra Karunaratne, Michigan State University
Joyce Parker, Michigan State University
Mary Lundeberg, Michigan State University
Matthew J. Koehler, Michigan State University
Jan Eberhardt, Michigan State University

S4.11.2 Gauging Changes in Teachers' Science Content Knowledge: Can Problem-Based Professional Development Lead to Deeper Understanding of Science?

Tom J. McConnell, Ball State University
Joyce M. Parker, Michigan State University
Jan Eberhardt, Michigan State University
Jeannine C. Stanaway, Lansing Community College
Merle Heidemann, Michigan State University
Mark Urban-Lurain, Michigan State University

S4.11.3 Professional Development that Targets Problem-Based STEM Education for Secondary Science Teachers

Anila Asghar, The Johns Hopkins University
Roni Ellington, Morgan State University
Barry Aprison, The Johns Hopkins University
Eric Rice, The Johns Hopkins University
Francine Johnson, The Johns Hopkins University
Glenda Prime, Morgan State University

S4.11.4 Constraints or Structural Necessities? Teachers' Conceptualizations of the 'Messy' Elements of PBL
Rashmi Kumar, University of Pennsylvania
David Jarvie, Educational Consultant

Strand 10: Curriculum, Evaluation, and Assessment

S4.12 SC-Paper Set: Evaluating the Effect of Nanoscience and Material Science Curriculums
4:45pm – 6:15pm, Garden 4
Presider: Xiufeng Liu, State University of New York at Buffalo

S4.12.1 Design, Implementation, and Evaluation of the Effectiveness of a 12-Hour Middle School Instructional Unit for Size and Scale
Cesar Delgado, University of Michigan
Harry B. Short, University of Michigan
Joseph Krajcik, University of Michigan

S4.12.2 Design-Based Research on Materials Science: Modelling and Inquiring Sound Attenuation
Roser Pinto, Universitat Autonoma de Barcelona
Digna Couso, Universitat Autonoma de Barcelona
Maria Isabel Hernandez, Universitat Autonoma de Barcelona

S4.12.3 Durability of Conceptions of Big Ideas in Nanoscience
Thomas R. Tretter, University of Louisville
M. Gail Jones, North Carolina State University
Jennifer Wolf, University of Louisville

S4.12.4 The Impact of a Teaching Intervention for Size and Scale based on Conceptual Variations
Eun Jung Park, Northwestern University
Su Swarat, Northwestern University
Greg Light, Northwestern University
Denise Drane, Northwestern University

Strand 11: Cultural, Social, and Gender Issues

S4.13 Symposium: Place as a Construct in Science Teaching, Learning and Curriculum Design: Implications for Addressing Culture and Equity
4:45pm – 6:15pm, Salon VII
Presider: Carrie T. Tzou, University of Washington
Discussant: Angela Calabrese Barton, Michigan State University
Presenters: Giovanna Scalone, University of Washington
Philip Bell, University of Washington
Miyoun Lim, Georgia State University
Erika Tate, University of California, Berkeley
Sameer Honwad, Pennsylvania State University
Christopher Hoadley, Pennsylvania State University
Erich Schienke, Pennsylvania State University
Brent Yarnal, Pennsylvania State University

Strand 12: Educational Technology

S4.14 SC-Paper Set: How Can Modeling Technologies Promote Understanding of Microscopic Phenomena?
4:45pm – 6:15pm, Salon VIII
Presider: Miri Barak, Technion - Israel Institute of Technology

S4.14.1 Research on Universal Design for Learning in Grades 3-6 Science Education
Robert Tinker, The Concord Consortium, MA
Carolyn Staudt, The Concord Consortium, MA
Andrew A. Zucker, The Concord Consortium, MA

S4.14.2 Building Models from Scratch
Brian Foley, CSU Northridge
Jarod Kawasaki, Cleavland High School

S4.14.3 Students' Understanding of Protein Structure and Function via Computerized Molecular Modeling
Miri Barak, Technion - Israel Institute of Technology
Rania Hussein-Farraj, Technion – Israel Institute of Technology

S4.14.4 Can Drawing Molecular Ideas Improve Learning from Computational Visualizations?
Zhihui Helen Zhang, University of California, Berkeley

Strand 13: History, Philosophy, and Sociology of Science

S4.15 Symposium: Research on Science Issues of Social and Personal significance: Understanding Students' Decision-Making, Creating Meaningful Curriculum, and Educating Teachers
4:45pm – 6:15pm, Garden 1
Presider: Felicia M. Moore Mensah, Columbia University
Discussant: Dana L. Zeidler, University of South Florida
Presenters: Teresa Greely, University of South Florida
Meghan E. Marrero, Columbia University
Jennie S. Brotman, Columbia University
Aarti Mallya, Columbia University
Brendan E. Callahan, University of South Florida

Strand 14: Environmental Education

S4.16 SC-Paper Set: Enhancing Student Learning through Environmental Education
4:45pm – 6:15pm, Salon VI
Presider: David Zandvliet, Simon Fraser University

S4.16.1 Student Conceptions of Global Warming and Climate Change
Daniel P. Shepardson, Purdue University
Soyoung Choi, Purdue University
Dev Niyogi, Purdue University
Umarporn Charusombat, Purdue University

S4.16.2 Field Science: A More Inclusive Science for High School Students?
Terry M. Tomasek, Elon University
Catherine E. Matthews, University of North Carolina

S4.16.3 Addressing the Challenges in Understanding Ecosystems: Why Getting Kids Outside May Not Be Enough
Tina A. Grotzer, Harvard University
Christopher J. Dede, Harvard University
Shari Metcalf-Jackson, Harvard University
Jody Clarke, Harvard University

S4.16.4 Learning About Ecology through Causal Concept Mapping
Rod D. Roscoe, Vanderbilt University
Nancy P. Morabito, Vanderbilt University
Gautam Biswas, Vanderbilt University

Evening/Social Events

Membership and Elections Committee Sponsored Session

Graduate Student Forum

The Graduate Student Forum aims to guide and encourage beginning researchers by discussing various problems that may arise, e.g. when completing the dissertation or searching for a position. Attendees of the forum are given the opportunity to question a panel of experienced colleagues on all matters of academic interest.

6:30pm – 7:30pm, Pacific Room

Mary M. Atwater, University of Athens
Kathryn Drago, University of Michigan
Catherine Koehler, University of Cincinnati
Eileen Parsons, University of North Carolina at Chapel Hill

JRST Editorial Board Meeting/Dinner

Meeting is open to all; dinner is by invitation only.

7:00pm – 9:00pm, Terrace Room

Sunday, April 19, 2009

Committee Meetings

7:00am – 8:15am

All members of NARST committees are required to attend the committee meetings. The meetings are open to other NARST members interested in attending the meeting.

Outstanding Doctoral Research Award Committee Meeting

7:00am – 8:15am, Salon II

Deborah Tippins (Co-Chair)
Julie Kittleson (Co-Chair)
Michael E. Beeth
Sharon Dotger
Mehmet Aydeniz
Alejandro Gallard
Jim Shymansky
Ratna Narayan
Edward Robeck
Tim Slater
Norm Thomson
Tracy Hogan
Lynn Dierking
John Lemberger

NARST Outstanding Paper Award Selection Committee Meeting

7:00am – 8:15am, Salon III

Anil C. Banerjee (Co-Chair)
Ann Cavallo (Co-Chair)
Greg Rushton
Orvil White
Nader Wahbeh
Nam Hwa Kang
Judy Lederman
Jennifer Adams
Jacob Blickenstaff
Kent Crippen
Brian Gerber
Shirley Gholston Key
Sonya Martin
Julie A. Thomas
Danielle Dani
Elaine Howes
Ozgul Yilman-Tuzun
Wendy Frazier
Karleen Goubeaud
Rhea Miles
Sara Salloum

Early Career Research Award Selection Committee Meeting

7:00am – 8:15am, Salon IV

Larry Flick (Co-Chair)
Randy Bell (Co-Chair)
Anita Roychoudhury
Heidi Carlone
Bill Harwood
Per-Olof Wickman
Fouad Ab-El-Khalick
Ed Marek
Hsin-Kai Wu
Kathy Trundle
Joe Krajcik

JRST Award Selection Committee Meeting

7:00am – 8:15am, Salon V

Hsiao-Ching She (Co-Chair)
Deborah L. Hanson (Co-Chair)
Jennifer L. Cartier
Carol Johnston
Scott McDonald
Erminia Pedretti
Meredith Park Rogers
Rebecca Schneider
Shirley Simon
William Veal
Claudia Von Aufschnaiter
Gayle Buck
Nate Carnes
Hasan Deniz
Lisa Donnelly
Benny Yung
Xiufeng Liu
Gail Richmond
James Minoque
Edna Tan
Douglas Huffman
Eva Toth
Magnia George
BaoHui Zhang
Jazlin Ebenezer
Huann-shyang Lin

Equity and Ethics Committee Meeting

7:00am – 8:15am, Salon VI

Valarie L. Akerson (Chair)
Heidi Carlone
Maria Rivera
Gayle Buck
Sunday, April 19, 2009

Felicia Moore
Lisa Martin-Hansen
Jrene Rahm
Michiel van Eijck
Sumi Hagiwaraas
Kathy Fadigan

External Policy and Relations Committee Meeting

7:00am – 8:15am, Salon VIII

Lynn Bryan (Co-Chair)
Betsy Davis (Co-Chair)
Janet Carlsen-Powell
Julie Luft
Eileen Parsons

Carla C. Johnson
Mike Vitale
Sharon Lynch
Christopher Miller
Andrew Shouse
Kevin Holtz

Research Committee Meeting
7:00am – 8:15am, Grand Ballroom D

Randy Yerrick (Co-Chair)
Troy Sadler (Co-Chair)
Martina Nieswandt
Kadir Demir
Julia V. Clark
Anita Roychoudhury
Dale R. Baker
Gavin Fulmer
Ajda Kahveci
James Otuka
Colette Murphy

Membership and Election Committee Meeting
7:00am – 8:15am, Grand Ballroom F

Reinders Duit (Chair)
Penny J. Gilmer (Co-Chair)
Kathryn Drago
Laura Henriques
Catherine Koehler
Mary Atwater
Julia (Julie) Grady
James Tarleton Mcdonald III
Jan van Driel
April Adams
Adin Amirshokoohi

International Committee Meeting
7:00am – 8:15am, Grand Ballroom G

Mei-Hung Chiu (International Coordinator)
Eduardo Mortimer
Soonhye Park
Sibel Erduran
Barbara G. Ladewski
Uri Zoller
Irene Osisioma
Max Dass
Knut Neumann
Feral Ogan-Bekiroglu

Program Committee Meeting
7:00am – 8:15am, Garden 1

All strand coordinators must attend. The purpose of the meeting is to continue work from previous day and draft call for papers for the 2010 conference. Additionally, the NARST online abstract module will be demonstrated to prepare committee members for the work they will undertake next year.

Charlene M. Czerniak, President
Rick Duschl, President-Elect
Catherine Milne
Eric Wiebe
Wesley Pitts
Erin Dolan
Jan H. van Driel
Terry Shanahan
Lisa Martin-Hansen
Helen Meyer
Kate Popejoy
Tahsin Khalid
Tali Tal
Jim Kisiel
Christina Schwarz
Amelia Wenk-Gotwals
Martina Nieswandt
Kimberly Fluet
Jerine Pegg
Erin Peters
Bruce Waldrip
Xiufeng Liu
Magnia A. George
Bhaskar Upadhyay
Hsin-Kai Wu
Hee-Sun Lee
Agustín Adúriz-Bravo
Reneé Schwartz
Eleanor Abrams
Rita Anne Hagevik
Teddie Phillipson-Mower
Sharon Lynch
Sarah Carrier

Distinguished Contributions in Research Award Committee Meeting
7:00am – 8:15am, Garden 2

David Treagust (Co-Chair)
Kenneth Tobin (Co-Chair)
Stephen Norris
Reinders Duit
Julie Bianchini
Meta VanSickle
Kate Scantlebury
Justin Dillon
Nancy Romance

Publications Advisory Committee Meeting
7:00am – 8:15am, Garden 3

Carla Zembal-Saul (Chair)
Hedy Moscovici
Tamara Nelson
Kate McNeill
Reneé Schwartz
Kathy Roth
Tali Tal
Len Annetta
Kate Popejoy
Gill Roehrig
J. Randy McGinnis (JRST Co-Editor)
Angelo Collins (JRST Co-Editor)

Concurrent Session #5
8:30am – 10:00am

Publications Advisory Committee Sponsored Session
S5.1 Symposium: Publication in the Journal of Research in Science Teaching
8:30am – 10:00am, Grand Ballroom D
Presider: J. Randy McGinnis, University of Maryland
Presenters:
Angelo Collins, Knowles Science Teaching Foundation
Amy Dai, University of Maryland
Wayne Breslyn

Strand 1: Science Learning, Understanding and Conceptual Change

S5.2 SC-Paper Set: Nature of Science and Thinking about Thinking
8:30am – 10:00am, Grand Ballroom F
Presider: Richard Gunstone, Monash University

S5.2.1 Exploring Coherence between Grade Six Children's Views of the Nature of Science and Their Views of the Natural World
Robyn Garlick, University of Cape Town
Rudiger C. Laugksch, University of Cape Town

S5.2.2 Students´ Beliefs on the Nature of Science and the Development of Inquiry Competence: A Longitudinal Study
Kerstin Kremer, Justus-Liebig-University Gießen
Detlef Urhahne, Ludwig-Maximilians-University Munich
Jürgen Mayer, Justus-Liebig-University Gießen

S5.2.3 The Relationship of Pupils' Epistemology, Metacognition, Cognitive Structures and Scientific Achievement: A Path Analysis Study
Chao-Ming Huang, National Taiwan University
Chin-Chung Tsai, National Taiwan University of Science and Technology

S5.2.4 Using Students' Conceptions of the Nature of Scientific Knowledge to Inform Dimensions of Epistemological Beliefs and the Nature of Science
Julie M. Kittleson, University of Georgia

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S5.3 SC-Paper Set: Fostering Professional Relationship and Student Experiences in Science Education
8:30am – 10:00am, Garden 3
Presider: Femi Otulaja, City University of New York

S5.3.1 Pedagogical Repairs for Dealing with Trouble in a Science Internship
Pei-Ling Hsu, University of Victoria
Wolff-Michael Roth, University of Victoria

S5.3.2 A Phenomenological Exploration of Secondary Science Students' Experiences during First-Year Implementation of Project-Based Learning
Amy E. Trauth-Nare, Indiana University
Gayle A. Buck, Indiana University
Meredith A. Park Rogers, Indiana University

S5.3.3 Co-Teaching in the University of Pennsylvania's Science Teacher Institute. Collaboration between University Faculty and High School Teachers
Cristobal Carambo, University of Pennsulvania
Constance Blaisie

S5.3.4 Do Students Experience Project-Based Laboratory Curricula as Motivating? A Study of an Organic Chemistry Laboratory Curriculum
Gail S. Horowitz, Yeshiva University

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies

S5.4 SC-Paper Set: Primary Science Teachers' Knowledge and Beliefs
8:30am – 10:00am, Garden 2
Presider: Elizabeth Davis, University of Michigan

S5.4.1 Constructing a Multiple Choice Test to Measure Teachers' Pedagogical Content Knowledge in Primary Technology Education
Ellen J. Rohaan, University of Technology, The Netherlands
Ruurd Taconis, University of Technology, The Netherlands
Wim Jochems, University of Technology, The Netherlands

S5.4.2 Data in Search of a Theory: A Dual Coding Theory Analysis of Elementary Teachers' Science Learning
Suzanne M. Levine, University at Albany
Cheryl Sheehan, University at Albany
Audrey B. Champagne, University at Albany
Vicky L. Kouba, University at Albany

S5.4.3 Classroom Inquiry Style: A Missing Link Interconnecting Content Knowledge, Topic-Specific Science Teaching and Orientations toward Teaching Science
Annmarie R. Ward, Penn State University
Carla Zembal-Saul, Penn State University

S5.4.4 Exploring Elementary Preservice Teachers' Beliefs and Knowledge about Science Teaching and Learning Emerging From Metaphor Writing
Eulsun Seung, Indiana State University
Soonhye Park, University of Iowa
Ratna Narayan, Texas Tech

S5.4.5 Tenet Building: Researching the Place of Generic Science-Content Free Activities to Develop Elementary and Kindergarten Teachers' Understanding of the Nature of Science
Rena Heap, University of Auckland

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies

S5.5 SC-Paper Set: Inquiry and Nature of Science in the Secondary Science Classroom
8:30am – 10:00am, Salon III
Presider: Norman Thomson, University of Georgia

S5.5.1 Capturing Urban Middle School Students' Voices on the Use of Science Inquiry in their Classrooms
Irene U. Osisioma, California State University
Chidiebere Onyia, Lynwood Unified School District, California
Mercy Ogunsola-Bandele, Adamawa State University, Nigeria

S5.5.2 Characterizing Middle School Science Teachers' Informal Formative Assessment Strategies and Their Effects on Student Inquiry Skills
Joseph A. Brobst, University of Delaware
Eric Eslinger, University of Delaware

S5.5.3 Comparison of Views about Inquiry-Based Teaching Held by Science Teachers from Hong Kong, Mainland China and United States
Siu Ling Wong, The University of Hong Kong
Benny H.W. Yung, The University of Hong Kong
Yu-ying Guo, Beijing Normal University, China
Norman G. Lederman, Illinois Institute of Technology
Judith S. Lederman, Illinois Institute of Technology

S5.5.4 Converging Paths: Change in the Beliefs about Teaching and the Nature of Science amongst Certified and Alternatively Certified Secondary Science Teachers
Jonah B. Firestone, Arizona State University
Krista Adams, Arizona State University
Julie A. Luft, Arizona State University
Jenn Neakrase, Arizona State University
EunJin Bang, Iowa State University
Irasema Ortega, Arizona State University
Sissy Wong, Arizona State University

S5.5.5 Investigating Elementary Students' Nature of Science Views
Esme Hacieminoglu, Selcuk University, Turkey
Ozgul Yilmaz Tuzun, Middle East Technical University, Turkey
Hamide Ertepinar, Middle East Technical University, Turkey

Strand 5: College Science Teaching and Learning (Grades 13-20)

S5.6 SC-Paper Set: Current Themes in Evolution Pedagogy
8:30am – 10:00am, Salon IV
Presider: Jason Wiles, Syracuse University

S5.6.1 Evolution and Personal Religious Belief: Christian Biology-Related Majors' Search for Reconciliation at a Christian University
Mark W. Winslow, Southern Nazarene University
John R. Staver, Purdue University
Larry C. Scharmann, Kansas State University

S5.6.2 Reinforcing Macroevolutionary Misconceptions: Students' Interpretations Of Textbook Diagrams
Kefyn M. Catley, Western Carolina University
Laura R. Novick, Vanderbilt University
Courtney Shade, Vanderbilt University

S5.6.3 Testing a Model of Representational Competence Applied to Phylogenetic Tree Thinking
Kristy L. Halverson, University of Missouri
Sandra K. Abell, University of Missouri
Patricia M. Friedrichsen, University of Missouri
J. C. Pires, University of Missouri

S5.6.4 Does the Nature of Science Instruction Influence College Students' Learning of Biological Evolution?
Wilbert Butler, Tallahassee Community College
Sherry A. Southerland, Florida State University

Strand 6: Science Learning in Informal Contexts

S5.7 Symposium: Informal Science Institutions and Learning Sciences: Intersections of Theories, Methods, and Implications to Practice
8:30am – 10:00am, Salon V

Presider: Sandra T Martell, University of Wisconsin-Milwaukee
Presenters: Heather Zimmerman, Pennsylvania State University
Molly Reisman, King's College London, England
Maria Xanthoudaki, National Museum of Science and Technology Leonardo da Vinci, Italy
Mele Wheaton, University of California, Santa Cruz
Jennifer DeWitt, King's College London, England
Sandra Murriello, State University of Campinas, Brazil
Jesus Piqueras, Stockholm University, Sweden
Bronwyn Bevan, Center for Informal Learning and Schools at the Exploratorium

Strand 7: Pre-service Science Teacher Education

S5.8 Symposium: Developing a Common Research-Based, Words-to-Images Language: The ViSTA Teacher Educator Community
8:30am – 10:00am, Salon II

Presider: Karen B Givvin, LessonLab Research Institute
Presenters: Malcolm Butler, University of South Florida
Robert Hollon, University of Wisconsin, Eau Claire
Karynne Klein, Georgia College and State University
Paula Lane, Sonoma State University
Kate Popejoy, University of North Carolina, Charlotte
Roberta Aram, Missouri State University
Maria Lawrence, Rhode Island College
Janice Meyer, Texas A&M
Deborah Smith, Penn State

Strand 8: In-service Science Teacher Education

S5.9 SC-Paper Set: Communities of Practice
8:30am – 10:00am, Salon I

Presider: Gail Richmond, Michigan State University

S5.9.1 Professional Learning Communities, Teacher Change, and Student Achievement
Gail Richmond, Michigan State University
Daniel Birmingham, Michigan State University

S5.9.2 Three Dimensions of Teachers' Collaborative Inquiry: Using Data to Improve Science Teaching & Learning
Tamara Holmlund Nelson, Washington State University
David Slavit, Washington State University
Angie Deuel Foster, Washington State University
Anne Kennedy, Washington State University

S5.9.3 Lesson Study: Professional Development for Improving Classroom Practice
Robin R. Smith, Florida State University

S5.9.4 Challenges and Opportunities Associated with Community-Based Professional Development: A Model for Sustaining Reform-Based Science Teaching in Urban Settings
Viola Manokore, Michigan State University
Gail Richmond, Michigan State University

Strand 9: Reflective Practice

S5.10 Symposium: Promoting Professional Identity Development through Science Teacher Action Research
8:30am – 10:00am, Grand Ballroom G

Presider: Brenda M. Capobianco, Purdue University
Presenters: Allan Feldman, University of Massachusetts Amherst
Tarin Weiss, Westfield State College
Elaine Howes, University of South Florida
Rachel Mamlok-Naaman, Weizmann Institute of Science
Karen Goodnough, Memorial University of Newfoundland

Strand 10: Curriculum, Evaluation, and Assessment

S5.11 Symposium: Assessment Linked to Middle School Science Learning Goals: What Middle School Students Know
8:30am – 10:00am, Garden 4

Presider: George E. DeBoer, Project 2061 / AAAS
Presenters: Cari F. Herrmann-Abell, Project 2061 / AAAS
Jill A. Werthiem, Project 2061 / AAAS
L. Karina Nabors, Project 2061 / AAAS
Jo Ellen Roseman, Project 2061 / AAAS

Strand 12: Educational Technology

S5.12 Strand Invited Symposium: Visualizations for Science Learning: Molecular Workbench, Virtual Worlds, and Handheld Computers
8:30am – 10:00am, Salon VIII

Presider: Hee-Sun Lee, Tufts University
Discussant: Marcia C. Linn, University of California, Berkeley
Presenters: Robert Tinker, Concord Consortium
Constance Steinkuehler, University of Wisconsin, Madison
Chris Quintana, University of Michigan

Strand 13: History, Philosophy, and Sociology of Science

S5.13 Poster Symposium: Argumentation, Epistemic Operations and the Nature of Science
8:30am – 10:00am, Garden 1

Presider: Agustín Adúriz-Bravo, Universidad de Buenos Aires
Discussants: Reneé Schwartz, Western Michigan University

S5.13.1 Argumentation Strategies in Learning and Teaching Chemistry
María Eugenia De la Chaussée Acuña, Universidad Iberoamericana de Puebla, Mexico

S5. 13.2 Argumentation and Epistemic Criteria: Learning Reasons for Reasons
Richard Duschl, Pennsylvania State University
Gregory J. Kelly, Pennsylvania State University

S5.13.3 Cool Argument: Investigating the Epistemic Levels and Argument Quality in Engineering Students' Written Arguments about the Peltier Effect in Refrigeration
Sibel Erduran, University of Bristol, UK
Rosa Villamañán, Universidad de Valladolid, Spain

S5.13.4 School Scientific Argumentation and the Cognitive Model of School Science
Mercè Izquierdo Aymerich, Universitat Autònoma de Barcelona, Spain

S5.13.5 School Scientific Argumentation: Epistemic Components in Teachers' Written Productions
Adrianna Gómez, Unidad Monterrey-Cinvestav, Mexico
Patricia Iglesia, Universidad de Buenos Aires, Argentina
Ana Couló, Universidad de Buenos Aires, Argentina

S5.13.6 The Place of Argumentation in Undergraduate Chemistry Teaching
Salete Linhares Queiroz, Universidade de São Paulo, Brasil
Luciana Passos Sá, Universidade de São Paulo, Brasil

S5.13.7 Argumentation, Authorship and Genre in Texts from a Teacher Education Journal
Isabel Martins, Universidade Federal do Rio de Janeiro, Brasil

S5.13.8 Argumentation as Epistemic Practice in the Context of Socioscientific Issues
Troy D. Sadler, University of Florida

S5.13.9 Argumentation and the Nature of Science
Gábor Zemplén, Budapest University of Technology and Economics, Hungary

Strand 14: Environmental Education

S5.14 SC-Paper Set: Teachers Impact on Environmental Education
8:30am – 10:00am, Salon VI

Presider: Steven Semken, Arizona State University

S5.14.1 Investigating Rural Kenyan Teachers' Conceptions of Snakes: Alternative Perspectives for Teaching
David Wojnowski, University of North Texas

S5.14.2 Case Studies of Participatory Action Research using the Place-Based Learning and Constructivist Environment Survey (PLACES)
David B. Zandvliet, Simon Fraser University
Marlene Nelson, Simon Fraser University

S5.14.3 Investigating Preservice Teachers' Environmental Literacy through their Epistemological Beliefs
Gokhan Ozturk, Middle East Technical University
Ozgul Yilmaz Tuzun, Middle East Technical University
Gaye Teksoz Tuncer, Middle East Technical University

S5.14.4 Teacher Engagement in Climate Change Education
Joan M. Chambers, Lakehead University

Break
10:00am – 10:30am

Plenary Session

PL. 2 Grand Challenges in Science Education: What's Foundational for Science Learning?

10:30am – 11:45am, Grand Ballroom A


Leona Schauble

Presider: Richard A. Duschl, Penn State University

Presenter: Leona Schauble, Vanderbilt University

Awards Luncheon

12:00pm – 1:45pm, Royal Ballroom

All NARST members should plan to attend the Awards Luncheon. The meal is included in the cost of your conference registration.

Concurrent Session #6
2:00pm – 3:30pm

Presidential Invited Session

S6.1 NARST's Grand Challenges and Great Opportunities: Presidential Speech Reaction Panel
2:00pm – 3:30pm, Grand Ballroom D
Presider: Charlene M. Czerniak
Panel Members: Sandra Abell, University of Missouri
Charles Andy Anderson, Michigan State University
Jane Butler Kahle, Miami University, Ohio
Angela Calabrese Barton, Michigan State University
Audrey Champagne, SUNY at Albany
Penny J. Gilmer, Florida State University
William G. Holliday, University of Maryland
Joseph Krajcik, University of Michigan
Julie Luft, Arizona State University
Felicia Moore, Columbia University
Leonie Rennie, Curtin University, Australia
Dana Zeidler, University of South Florida

Strand 1: Science Learning, Understanding and Conceptual Change

S6.2 SC-Paper Set: Informal Reasoning, Argumentation, and Metacognition
2:00pm – 3:30pm, Grand Ballroom F
Presider: Colette Murphy, Queens University Belfast

S6.2.1 An Investigation into the Relative Effects of Inquiry-Based and Commonplace Science Teaching on Students' Knowledge, Reasoning and Argumentation: A Randomized Control Trial
Christopher D. Wilson, BSCS Center for Research and Evaluation
Joseph A. Taylor, BSCS Center for Research and Evaluation
Susan M. Kowalski, BSCS Center for Research and Evaluation

S6.2.2 The Effects of On-Line Searching Activities on High School Students' Informal Reasoning on a Socio-Scientific Issue
Ying-Tien Wu, National Taichung University, Taiwan
Chin-Chung Tsai, National Taiwan University of Science and Technology

S6.2.3 What Makes a Scientific Argument Persuasive? How Middle and High School Students View Different Types of Arguments
Jonathon Grooms, The Florida State University
Victor Sampson, The Florida State University
Leeanne Gross, The Florida State University

S6.2.4 The use of Metacognition during Error Correction by High School Physics Students – An Exploration
Kathy L. Malone, Shady Side Academy, PA

Strand 1: Science Learning, Understanding and Conceptual Change

S6.3 Related Paper Set: Young Children's Conceptions of the Moon
2:00pm – 3:30pm, Grand Ballroom G
Presider: Kathy Cabe Trundle, The Ohio State University

S6.3.1 Children's Stories and Ideas about the Moon
Robert D. Louisell, St. Ambrose University
Francis E. Kazemek, St. Cloud State University
Jerry Wellik, St. Cloud State University

S6.3.2 A Case Study of Three Children's Original Interpretations of the Moon's Changing Appearance
Jennifer A. Wilhelm, Texas Tech University

S6.3.3 A Sociocultural Perspective on Young Children's Conceptions of the Moon
Grady J. Venville, University of Western Australia

S6.3.4 Young Children's Conceptual Universtanding about the Moon Before and After an Inquiry-Based, Technology-Enhanced Experience
Sally M. Hobson, The Ohio State University
Kathy Cabe Trundle, The Ohio State University
Mesut Sackes, The Ohio State University

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S6.4 SC-Paper Set: Fostering Collective Responsibility in Science Education across Gender and Other Social Boundaries
2:00pm – 3:30pm, Garden 1
Presider: Alandeom Oliveira, University at Albany, SUNY

S6.4.1 Freshmen Students' Chemistry Self-Efficacy in Relation to Goal Orientation, Gender, and Academic Achievement
Betul Demirdogen, Zonguldak Karaelmas University
Esen Uzuntiryaki, Middle East Technical University
Yesim Capa Aydin, Middle East Technical University

S6.4.2 Data Logging in Senior High Science: Are we Disadvantaging Females?
Ronald J. MacDonald, University of Prince Edward Island
Angela F. Larter, University of Prince Edward Island
Jeff Carragher, Eastern School District
Chris Higginbotham, Western School Board
Lisa Ling, Eastern School District
Ryan McAleer, Western School Board
Dave Ramsay, Western School Board
Steven Wynne, Eastern School District

S6.4.3 The Differential Role of "The Message" and "The Messenger" in the Learning Process
Meena M. Balgopal, Colorado State University

S6.4.4 The Organic Chemistry Workshop: Fostering Individual & Collective Responsibility for Learning
Karen E. S. Phillips, Hunter College of CUNY

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S6.5 Symposium: Quality of Instruction in Science Education
2:00pm – 3:30pm, Garden 3
Presider: Knut Neumann, University Duisburg-Essen
Presenters: Birgit J. Neuhaus, University of Munich
Hans E. Fischer, University Duisburg-Essen
Angela Sandmann, University Duisburg-Essen
Elke Sumfleth, University Duisburg-Essen

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies

S6.6 Strand Invited Symposium: The Importance of Elementary Science Education in the NCLB Era
2:00pm – 3:30pm, Garden 2
Presider: Therese Shanahan, UC Irvine
Presenters: Julie Gess-Newsome, Northern Arizona University
Reneé Schwartz, Western Michigan University
Deborah Hanuscin, University of Missouri
Joanne Olson, Iowa State University
Deborah Smith, Penn State University
Marian Pasquale, Education Development Center
Abigail Levy, Education Development Center

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies

S6.7 Related Paper Set: Teachers' Professional Knowledge for Integrating Nanoscience and Engineering into Middle School Science Curricula
2:00pm – 3:30pm, Salon III

S6.7.1 Overview of Teachers' Professional Knowledge for Integrating Nanoscience and Engineering into Middle and High School Science Curricula
Lynn A. Bryan, Purdue University

S6.7.2 Middle and High School Teachers' Development of Nanoscience and Engineering Subject Matter Knowledge
David Sederberg, Purdue University
Shanna Daly, Purdue University and University of Michigan
Lynn A. Bryan, Purdue University

S6.7.3 Determining the Role of and Developing Instruction for Models in Nanoscale Science and Engineering Education
Shanna Daly, Purdue University and University of Michigan
Lynn A. Bryan, Purdue University

S6.7.4 Where Does Nanoscience Fit? An Analysis of Middle and High School Science Teachers Nanoscience Lesson Plans
Emily Wischow, Purdue University
Lynn A. Bryan, Purdue University

S6.7.5 Mediators of Middle and High School Teachers' Integration of Nanoscale Science and Engineering Content into Their Existing Curriculum
Kelly Hutchinson, Purdue University
Lynn A. Bryan, Purdue University
Shanna Daly, Purdue University and University of Michigan

Strand 5: College Science Teaching and Learning (Grades 13-20)

S6.8 SC-Paper Set: Issues in Interdisciplinary Science
2:00pm – 3:30pm, Salon IV

S6.8.1 Investigating Post-Secondary Students' Perceptions Of Temporal Scales Associated With Scientific Changes
Hee-Sun Lee, Tufts University
Charles A. Price, Tufts University

S6.8.2 Gender-Based Geospatial Differences in College Students
Iris Totten, Kansas State University
Juli Moore, Michigan State University

S6.8.3 Using Concept Maps to Evaluate Conceptions of the Nature of Science among Prospective Elementary Teachers
Catherine S. Martin-Dunlop, California State University, Long Beach

S6.8.4 Implementation Study of a Novel Science Curriculum for First Year College Students "A Case Study of Columbia's Frontiers in Science"
Julia E. Sable, Columbia University

Strand 6: Science Learning in Informal Contexts

S6.9 SC Paper Set: Challenges of Science Learning Across Multiple Contexts-Round Table Discussions
2:00pm – 3:30pm, Salon V
Presider: Jennifer DeWitt, King's College London, England

S6.9.1 Young Scientists at Summer Camp
Ann Sherman, University of Calgary
A. Leo MacDonald, St. Francis Xavier University

S6.9.2 Science Center Program Development for Schools: Challenges and Opportunities
Patricia M. Rowell, University of Alberta

S6.9.3 Learning and Becoming across Time and Space: Insights from a Fire Ecology Project and a Garden Program
Jrène Rahm, Université de Montréal, Canada
Allison J. Gonsalves, McGill University, Canada
John C. Moore, Colorado State University

S6.9.4 Outdoor Learning in the Rainforest: Addressing Students' Questions and their (Mis)conceptions through Experiential Learning
Christine Chin, Nanyang Technological University, Singapore
Tayeb bin Rajib, St Stephens School, Singapore

S6.9.5 Understanding Emergent Challenges and Adaptations in the Design of an OST STEM Project through a Structure, Behavior and Function (SBF) Complexity Lens
Susan Yoon, University of Pennsylvania
Melissa Chessler, University of Pennsylvania
Rashmi Kumar, University of Pennsylvania
Darryl Williams, University of Pennsylvania
Jacqueline Flicker, University of Pennsylvania
Sandra Dunham, University of Pennsylvania

S6.9.6 Informal Learning in Formal Settings
Janette Griffin, University of Technology, Australia
Peter Aubusson, University of Technology, Australia

Strand 7: Pre-service Science Teacher Education

S6.10 SC-Paper Set: The Role of Field Experiences in Preservice Teachers' Development
2:00pm – 3:30pm, Salon II
Presider: Carla Zembal-Saul, Penn State University

S6.10.1 Out in the Field: Evaluating Elementary Science Teacher Efficacy and Elementary Teacher Efficacy in Preservice Elementary Teachers
Ron R. Wagler, University of Texas at El Paso

S6.10.2 Concept Map Assessment of Preservice Teachers' Increased Science Content Knowledge as the Result of One-to-One Clinical Field Experiences
Julie Thomas, Oklahoma State University
Ratna Narayan, Texas Tech University

S6.10.3 Pre-service Science Teachers' Reflections upon their Micro-Teaching Experience: An Activity Theory Perspective
Asli Sezen, Pennsylvania State University
Minh-Dan T. Tran, Pennsylvania State University
Scott P. McDonald, Pennsylvania State University
Gregory J. Kelly, Pennsylvania State University

S6.10.4 Yearlong Internship Program for Qualified STEM Teachers K-12
Shirley Zongker, UMBC
Anne Spence, UMBC
Teresa Irish, UMBC

S6.10.5 Constraints and Choice: The Field Experience of a Science Education Researcher
Selcen Guzey, University of Minnesota
Anne Kern, University of Idaho

Strand 8: In-service Science Teacher Education

S6.11 Symposium: Exploring Pathways for Science Teacher Transformation: Evidence for the Role of Context, Community, and Identity
2:00pm – 3:30pm, Salon I
Presider: Gail Richmond, Michigan State University
Discussants: Gail Richmond, Michigan State University
Cynthia Passmore, University of California, Davis
Kathleen Roth, LessonLab Research Institute
Viola Manokore, Michigan State University
Daniel Birmingham, Michigan State University
Lin Xiang, University of California, Davis
Connie Hvidsten, University of California, Davis
Richard Hedman, California State University, Sacramento

Strand 8: In-service Science Teacher Education

S6.12 Related Paper Set: Charting New Territory: The Learning of Early Career Science Teachers
2:00pm – 3:30pm, Salon VI
Presider: Julie Luft, Arizona State University

S6.12.1 Bringing Content into Induction Programs: Overlooked, but Necessary
Julie Luft, Arizona State University

S6.12.2 Progressive Development of Beginning Secondary Science Teachers: A Longitudinal Study
Steven Fletcher

S6.12.3 How Pedagogical Reasoning and Ambitious Practice Develops Across "Learning to Teach" Contexts
Jessica Thompson
Melissa Braaten, University of Washington
Mark Windschitl, University of Washington

S6.12.4 Fostering Ambitious Pedagogy in Novice Teachers: The Collaborative Analyses of Pupil Work as a Bridge between Teacher Education and Early Career Practice
Mark Windschitl, University of Washington
Jessica Thompson
Melissa Braaten, University of Washington

Strand 8: In-service Science Teacher Education

S6.13 SC-Paper Set: Conceptions, Misconceptions and Assessment
2:00pm – 3:30pm, Salon VIII
Presider: Miancheng Guo, Illinois Institute of Technology

S6.13.1 Identification and Analysis of Science Teachers' Preconceptions Related to Avian Influenza
William L. Romine, University of Missouri
Marcelle A. Siegel, University of Missouri
Tina M. Roberts, University of Missouri

S6.13.2 Chinese Middle School Science Teachers' Views of Nature of Science
Miancheng Guo, Illinois Institute of Technology
Norman G. Lederman, Illinois Institute of Technology
Martina Nieswandt, Illinois Institute of Technology

S6.13.3 Enhancing Secondary In-Service Mathematics & Science Teachers' Assessment Literacy through a Web-Based Training Model
Ya-Ching Fan, National Changhua University of Education
Kuo-Hua Wang, National Changhua University of Education
Tzu-Hua Wang, National Hsinchu University of Education

S6.13.4 Nanotechnology Education: Challenges and Opportunities Employing STEM Curriculum
Leslie Flynn, University of Minnesota
Jeffrey D. Long, University of Minnesota

Strand 10: Curriculum, Evaluation, and Assessment

S6.14 Related Paper Set: Development, Implementation and Assessment of Popular and Relevant Science Modules: The PARSEL Project
2:00pm – 3:30pm, Garden 4

S6.14.1 Increasing Science Teachers' Ownership through the Adaptation of the PARSEL Modules: A Bottom-Up Approach
Rachel Mamlok-Naaman, Weizmann Institute of Science, Israel
Ron Blonder, Weizmann Institute of Science, Israel
Mira Kipnis, Weizmann Institute of Science, Israel
Avi Hofstein, Weizmann Institute of Science, Israel

S6.14.2 Scientific Literacy, Nuclear Physics, Peace, and Sustainable Development
Georgios Tsaparlis, University of Ioannina, Greece
Sotiris Hartzavalos, University of Ioannina, Greece

S6.14.3 Enhancing Students' Interests in Learning Science by Creating Innovative Learning Environments – The Berlin-ParIS-Project "Bio-Energy Sources"
Claus Bolte, Freie University, Berlin
Birgit Kirschenmann, Freie University, Berlin

S6.14.4 Realizing PARSEL in German Schools – Interest, Scientific Literacy and German National Standards
Wolfgang Graeber, IPN, Kiel, Germany
Martin Lindner, IPN, Kiel, Germany

S6.14.5 The Readiness of Science Teachers to Implement PARSEL Modules for Enhancing Scientific Literacy, and their Ownership of the Implementation
Miia Rannikmae, University of Tartu, Estonia
Jack Holbrook, University of Tartu, Estonia
Klaara Kask, University of Tartu, Estonia

Strand 11: Cultural, Social, and Gender Issues

S6.15 Related Paper Set: Grand Challenges and Great Opportunities in Place-Based Education in Science: Towards Socio-Cultural and Cultural-Historical Perspectives
2:00pm – 3:30pm, Salon VII
Presider: Michiel van Eijck, Eindhoven University of Technology
Discussants: Steve Alsop, York University
Sheliza Ibrahim, York University

S6.15.1 Critical Science Agency: Science in the Making with and in Place
Miyoun Lim, Georgia State University
Angela Calabrese Barton, Michigan State University
Edna Tan, Michigan State University

S6.15.2 Engaging the Pre-theoretical through Place-based Education: A Foundation for Environmental/Science Education
Doug Karrow, Brock University

S6.15.3 Towards a Chronotopic Notion of "Place" In Place-Based Education in Science
Michiel van Eijck, Eindhoven University of Technology
Wolff-Michael Roth, University of Victoria

S6.15.4 The Roles of Place, Culture and Situated Learning in Teacher Agency in Science:
Pauline W.U. Chinn, University of Hawaii at Manoa

Strand 15: Policy

S6.16 Symposium: The Development of a National Curriculum in K-8 Science Education: How Should NARST Respond?
2:00pm – 3:30pm, Grand Ballroom E
Presider: Robert Sherwood, Indiana University - Bloomington
Presenters: Richard Duschl, Pennsylvania State University
Angelo Collins, Knowles Science Teaching Foundation
Leona Schauble, Vanderbilt University
Richard Lehrer, Vanderbilt University
Janice Earle, National Science Foundation
Page Keeley, National Science Teachers Association

Break
3:30pm – 4:00pm

Concurrent Session #7
4:00pm – 5:30pm

Presidential Invited Session

S7.1 Constructing Linear Measures from Rating Scale Data with Rasch Modeling
4:00pm – 5:30pm, Grand Ballroom D
Presider: Charlene M. Czerniak, The University of Toledo
Presenters:
Christine Fox, The University of Toledo
Toni Sondergeld, The University of Toledo

Equity and Ethics Committee Sponsored Session

S7.2 Symposium: Exploring the Grand Challenges and Great Opportunities in Realizing a More Equitable Science Education
4:00pm – 5:30pm, Grand Ballroom E
Discussant: Gayle A. Buck, Indiana University
Presenters: Jennifer Adams, Brooklyn College
Geary Cofford, University of Oklahoma
Cesar Delgado, University of Michigan
Allison Kang, University of Washington
Kihyun Ryoo, Stanford University
Stephanie D. Preston, Pennsylvania State University

Ad Hoc Committee on the History of Science Education Committee Sponsored Session

S7.3 Symposium: Increasing Our Influence with Today's Researchers, Practitioners, and Policymakers: Perspectives from Past and Present NARST Executive Secretaries and Directors
4:00pm – 5:30pm, Salon VIII
Presiders: Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign
William Holliday, University of Maryland
Presenters: (in order of their service as Executive Secretaries and Directors)
Paul Joslin (1975-80), Retired
William Holliday (1980-85), University of Maryland
Glenn Markle (1985-90), University of Cincinnati
John Staver (1990-95), Purdue University
John Tillotson (2002-07), Syracuse University
William Kyle (2007-2012), University of Missouri--St. Louis

Strand 1: Science Learning, Understanding and Conceptual Change

S7.4 SC-Paper Set: Teacher Education and Broader Questions about Transfer
4:00pm – 5:30pm, Grand Ballroom F
Presider: Adam Johnston, Weber State University

S7.4.1 Vygotsky and the Problem of the Zone of Proximal (Nearest) Development
Colette Murphy, Queens University Belfast

S7.4.2 The Role of Cognitive, Metacognitive, and Motivational Variables in Conceptual Change in Astronomy
Mesut Sackes, The Ohio State University
Kathy Cabe Trundle, The Ohio State University

S7.4.3 Participants' Thinking When Interacting with a Web-Based Environment to Help Elementary Teachers Better Understand Floating and Sinking
David E. Brown, University of Illinois at Urbana-Champaign
Seongmi Lee, University of Illinois at Urbana-Champaign

S7.4.4 The Three Dimensions of Transfer
Irit Sasson, Israel Institute of Technology
Yehudit Judy Dori, Israel Institute of Technology/Massachusetts Institute of Technology

S7.4.5 A Comparison of Didactic and Guided Inquiry Instruction in Facilitation of Transference
Sarah J. Rogers, Brigham Young University
Christina Fox Call, Brigham Young University
Laura P. Chisholm, Kearns Junior High
Christian K. Davies, Brockbank Junior High
David Kent, Independence High School
Adam Mitchell, Diamond Fork Junior HIgh
Sara Wurstn, American Leadership Academy
Dennis Eggett, Brigham Young University
Nikki L. Hanegan, Brigham Young University

Strand 1: Science Learning, Understanding and Conceptual Change

S7.5 Strand Invited Symposium: Finding Connections between Psychological and Sociological Perspectives in Conceptual Change
4:00pm – 5:30pm, Grand Ballroom G
Presider: Catherine Milne, New York University
Presenters:
David F. Treagust, Curtin University, Australia
Reinders Duit, Leibniz Institute for Science Education, Germany
Kenneth Tobin, City University of New York
Kathryn Scantlebury, University of Delaware
Sonya Martin, Drexel University
Michiel W. van Eijck, Eindhoven University of Technology, The Netherlands

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S7.6 SC-Paper Set: Discourse and the Logics of Argumentation in Science Communities
4:00pm – 5:30pm, Garden 2
Presider: Tanya Cleveland Solomon

S7.6.1 High School Students' Use of Argumentative Skills during Inquiry-Based Activities
Aracelis J. Scharon, IIT
Martina Nieswandt, IIT
Norman G. Lederman, IIT

S7.6.2 Analogical Mapping as a Scaffold for Student Argumentation
Brandon R. Emig, Penn State
Scott J. McDonald, Penn State
Carla Zembal-Saul, Penn State

S7.6.3 Classroom Communities Adaptations of the Practice of Scientific Argumentation
Leema K. Berland, University of Texas at Austin
Brian J. Reiser, Northwestern University

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies

S7.7 Symposium: A Longitudinal Study on Pedagogical Content Knowledge: Synthesizing our Research on Content, Pedagogy, and Practice
4:00pm – 5:30pm, Salon III
Presider: Valerie K Otero, University of Colorado Boulder
Discussants: Valerie K. Otero, University of Colorado Boulder
Noah D. Finkelstein, University of Colorado Boulder
Robert M. Talbot, University of Colorado Boulder
David C. Webb, University of Colorado Boulder
Laura J. Moin, University of Colorado Boulder
Michael W. Klymkowsky, University of Colorado Boulder
Joeseph Krajcik, University of Michigan

Strand 6: Science Learning in Informal Contexts

S7.8 Strand Invited Symposium: NARST CAISE Symposium: Exploring the ISE Landscape and Determining Value in Informal Science Contexts
4:00pm – 5:30pm, Salon V
Presider: John H. Falk, Oregon State University
Participants: Scott Randol, Oregon State University
Lynn D. Dierking, Oregon State University
Kevin Crowley, University of Pittsburgh
John Baek, Oregon State University

Strand 7: Pre-service Science Teacher Education

S7.9 Related Paper Set: Promoting Pre-Service Science Teachers' Knowledge for Teaching
4:00pm – 5:30pm, Salon II
Presider: Jan van Driel, Leiden University, The Netherlands
Discussant: Julie Gess-Newsome, Northern Arizona University

S7.9.1 The Development of PCK in the Context of Pre-Service Science Teacher Education
Jan van Driel, Leiden University, The Netherlands
Julie Gess-Newsome, Northern Arizona University

S7.9.2 Investigating the Development of Science Teaching Orientations during an Alternative Certification Program
Pat Brown, University of Washington at St. Louis
Pat Friedrichsen, University of Missouri

S7.9.3 The Role of Pre-service Elementary Teachers' Pedagogical Content Knowledge for Science Teaching in Learning to Engage in Curricular Planning
Carrie J. Beyer, University of Michigan
Elizabeth A. Davis, University of Michigan

S7.9.4 Learning to Teach and Teaching to Learn - Student Teachers´ Teaching Concerns for Learning to Teach Primary Science
Pernilla K. Nilsson, Halmstad University, Sweden

Strand 8: In-service Science Teacher Education

S7.10 Symposium: North Coast Teachers Touching the Sky: Lessons Learned, Challenges, and Paradoxes of Creating Coherent Professional Development
4:00pm – 5:30pm, Salon I
Presider: Kevin M. Carr, Pacific University
Discussants: Ed Armstrong, Tillamook School District #9, Oregon
Greg Bothun, University of Oregon
Edith Gummer, Northwest Regional Education Laboratory
Rick Kang, Friends of Pine Mountain Observatory, Oregon

Strand 8: In-service Science Teacher Education

S7.11 Related Paper Set: The Communication in Science Inquiry Project: The Challenges of Professional Development
4:00pm – 5:30pm, Salon VI

S7.11.1 The Challenge of Measuring Fidelity of Implementation of Professional Development
Dale R. Baker, Arizona State University
Nievita Bueno-Watts, Arizona State University
Elizabeth B. Lewis, Arizona State University
Senay Purzer, Purdue University

S7.11.2 The Impact of CISIP on Elementary Teachers' Views of Nature of Scientific and Scientific Communication
Gita Perkins, Arizona State University
Senay Purzer, Purdue University
Sibel Uysal, Arizona State University
Sissy Wong, Arizona State University
Dale R. Baker, Arizona State University
Elizabeth B. Lewis, Arizona State University
Rachelle Beard, Arizona State University

S7.11.3 From Professional Development to the Classroom: What Changes Do Students Experience?
Nievita Bueno-Watts, Arizona State University
Dale R. Baker, Arizona State University
Elizabeth B. Lewis, Arizona State University
Sibel Uysal, Arizona State University
Senay Purzer, Purdue University
Rachelle Beard, Arizona State University
Sissy Wong, Arizona State University
Gita Perkins, Arizona State University
Monica Pineda, Arizona State University
Michael Lang, Maricopa Community College District

S7.11.4 Using HLM to Analyze On-Going Teacher Professional Development and Implementation of Scientific Classroom Discourse Community Strategies
Elizabeth B. Lewis, Arizona State University
Dale R. Baker, Arizona State University
Michael Lang, Maricopa Community College District
Brandon Helding, Arizona State University

S7.11.5 The Relationship between Quality of Teacher-Designed Lesson Plans and Teaching
Rachelle Beard, Arizona State University
Elizabeth B. Lewis, Arizona State University
Senay Purzer, Purdue University
Sibel Uysal, Arizona State University
Sissy Wong, Arizona State University

Strand 10: Curriculum, Evaluation, and Assessment

S7.12 SC-Paper Set: Studying the Implementation and Scale-Up of Curriculum Innovations
4:00pm – 5:30pm, Garden 4
Presider: Kristin M. Nagy Catz, University of California, Berkeley

S7.12.1 Assessing Student Learning in a 6th – 8th Grade Space Science Curriculum
Kristin M. Nagy Catz, University of California, Berkeley
Ann Barter, University of California, Berkeley

S7.12.2 Development of a Fidelity of Implementation Observation Instrument for a Reform-Oriented Science Program
April L. Gardner, BSCS Center for Research and Evaluation
Janet Carlson, BSCS Center for Research and Evaluation
Jane O. Larson, BSCS Center for Research and Evaluation

S7.12.3 Effectiveness of a Middle School Chemistry Curriculum during Scale-Up: A Three- Year Perspective
Joi D. Merritt, University of Michigan
Namsoo Shinn, University of Michigan

S7.12.4 The Creation, Validation, and Reliability Associated with the EQUIP (Electronic Quality of Inquiry Protocol): A Measure of Inquiry-Based Instruction
Jeff C. Marshall, Clemson University

Strand 11: Cultural, Social, and Gender Issues

S7.13 Related Paper Set: Language of Science in Urban Schools: Transitions from d to D
4:00pm – 5:30pm, Salon VII
Presider: Piyush Swami, University of Cincinnati

S7.13.1 Comparative Discourse Analysis of Third Grade Urban and Suburban Students Learning Science
Carmen (Karin) I. Mendoza, University of Cincinnati
Piyush Swami, University of Cincinnati

S7.13.2 Learning to Move from d to D: Urban Preservice Science Teacher Candidates' Transition from Vernacular to the Language of Science
Hedy Moscovici, California State University
Irene Osisioma, California State University

S7.13.3 "Walk and Talk Like Scientists": Seventh Grade Urban Students Share Their Perceptions and Beliefs of How a Change in Science Classroom Instructional Practices Helped Them Make the Transition from the Language of Home to the Language of Science
Claudette L. Giscombe, University of Massachusetts, Amherst

S7.13.4 Moving From d to D through the Eyes of Five Urban African American Science Teachers
Pamela Fraser-Abder, New York University

Strand 13: History, Philosophy, and Sociology of Science

S7.14 SC-Paper Set: Science, Society, and Argumentation
4:00pm – 5:30pm, Garden 1
Presider: Saouma BouJaoude, American University of Beirut

S7.14.1 Situated Learning in Science Education: Socioscientific Issues as Contexts for Practice
Troy D. Sadler, University of Florida

S7.14.2 Relationship between Nature of Science and Argumentation Skills
Rola F. Khishfe, Loyola University Chicago

S7.14.3 College Students' Perspectives of Science in Their Everyday Lives
Jacqueline Wong, University of California, Los Angeles
William A. Sandoval, University of California, Los Angeles

S7.14.4 Science, Technology, and Society: A Deweyan Perspective
Nidaa Makki, The University of Akron
Wendy Sherman Heckler, Otterbein College

Evening/Social Events

International Journal of Science and Mathematics Education (IJSME) Editorial Board Meeting (by invitation only)

5:45pm – 6:45pm, Barcelona

Reception/Board Meeting for board members and reviewers of the International Journal of Science and Mathematics Education (IJSME).

Membership and Elections Committee Sponsored Session

New Researcher and Junior Faculty Early Career Discussion

This session is particularly designed for the early career, junior faculty who want support during the first years of their academic career. The focus will be a panel discussion with experienced faculty who can guide junior faculty through important issues that pertain to the tenure process and other issues. Discussion topics include, but are not limited to: publications, research in the new position, collaboration with different colleges within the university setting, teaching loads, the tenure and promotion process, etc. We invite all junior faculty interested in this topic to join us.

5:45pm – 6:45pm, Terrace Room

Laura Henriques, California State University, Long Beach

Jim McDonald, Central Michgian University

Equity Dinner

This dinner is held off site and is arranged by the Equity Chair. Members cover their own meal costs.

7:00pm – 9:00pm

Routledge/Taylor & Francis Reception (by invitation only)

7:30pm – 10:00pm, Harbor Room

Monday, April 20, 2009

Strand Meetings
7:00am – 8:15am
This committee meeting is open to all NARST members interested in learning more about the Strands. This is an opportunity to meet the coordinators, provide suggestions to the Strand's direction for next year's conference, and to become involved with the Strands.

Strand 1: Science Learning, Understanding and Conceptual Change
Meeting-7:00am – 8:15am, Grand Ballroom F
Catherine Milne
Eric Wiebe

Strand 2: Science Learning: Contexts, Characteristics and Interactions
Meeting-7:00am – 8:15am, Garden 3
Wesley Pitts
Erin Dolan

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies
Meeting-7:00am – 8:15am, Garden 2
Jan H. van Driel
Terry Shanahan

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies
Meeting-7:00am – 8:15am, Salon III
Lisa Martin-Hansen
Helen Meyer

Strand 5: College Science Teaching and Learning (Grades 13-20)
Meeting-7:00am – 8:15am, Salon IV
Kate Popejoy
Tahsin Khalid

Strand 6: Science Learning in Informal Contexts
Meeting-7:00am – 8:15am, Salon V
Tali Tal
Jim Kisiel

Strand 7: Pre-service Science Teacher Education
Meeting-7:00am – 8:15am, Salon II
Christina Schwarz
Amelia Wenk-Gotwals

Strand 8: In-service Science Teacher Education
Meeting-7:00am – 8:15am, Salon I
Martina Nieswandt
Kinberly Fluet

Strand 9: Reflective Practice
Meeting-7:00am – 8:15am, Grand Ballroom G
Jerine Pegg
Erin Peters

Strand 10: Curriculum, Evaluation, and Assessment
Meeting-7:00am – 8:15am, Garden 4
Bruce Waldrip
Xiufeng Liu

Strand 11: Cultural, Social, and Gender Issues
Meeting-7:00am – 8:15am, Salon VII
Magnia A. George
Bhaskar Upadhyay

Strand 12: Educational Technology
Meeting-7:00am – 8:15am, Salon VIII
Hsin-Kai Wu
Hee-Sun Lee

Strand 13: History, Philosophy, and Sociology of Science
Meeting-7:00am – 8:15am, Garden 1
Agustin Aduriz-Bravo
Reneé Schwartz

Strand 14: Environmental Education
Meeting-7:00am – 8:15am, Salon VI
Eleanor Abrams
Rita Anne Hagevik
Teddie Phillipson-Mower

Strand 15: Policy
Meeting-7:00am – 8:15am, Grand Ballroom E
Judy Dori
Sharon Lynch
Sarah Carrier

Concurrent Session #8
8:30am – 9:45am

Presidential Invited Session

S8.1 A Theory of Action for NSF Educational Research: Strategies and Directions of the Division of Research on Learning in Formal and Informal Settings (DRL)
8:30am – 9:45am, Grand Ballroom D
Joan Ferrini-Mundy, National Science Foundation
Janice Earle, National Science Foundation
Sharon Lynch, National Science Foundation

Research Committee Sponsored Session

S8.2 Technology Symposium: Changing the Way the World Learns
8:30am – 9:45am, Pacific Room
Kathleen Fisher, Center for Research in Mathematics and Science Education
Michelle Nolasco, Center for Research in Mathematics and Science Education
Ryan Gallagher, High Tech Middle School
Billy Chapman, Manual Editor for the TOOL

Strand 1: Science Learning, Understanding and Conceptual Change

S8.3 SC-Paper Set: Representing Matter I
8:30am – 9:45am, Grand Ballroom F
Presider: Karen Bledsoe

S8.3.1 High School Students' Understanding of Six Chemistry Concepts in Relation to Particulate Nature of Matter and Everyday Phenomena
Zubeyde D. Kirbulut, Middle East Technical University
Michael E. Beeth, University of Wisconsin Oshkosh

S8.3.2 Characteristics and Levels of Sophistication about Mental-Modeling Ability: A Preliminary Study on General Chemistry Students' Thinking Processes with Mental Models of Molecular Geometry and Polarity
Chia-Yu Wang, National Chiao Tung University
Lloyd H. Barrow, University of Missouri-Columbia

S8.3.3 Reforming the Teaching and Learning of the Macro/Submicro/Symbolic Representational Relationship in Chemical Education
David F. Treagust, Curtin University
John K. Gilbert, Reading University

S8.3.4 A Report of the Ways in Which High School Chemistry Students Attempt to Represent a Chemical Reaction at the Atomic/Molecular Level
Nathan B. Wood, North Dakota State University
Anne L. Kern, University of Idaho
Gillian Roehrig, University of Minnesota

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S8.4 SC-Paper Set: Contextual Factors and Patterns of Representation in Science Classrooms
8:30am – 9:45am, Garden 3
Presider: Troy D. Sadler, University of Florida

S8.4.1 Multiple Modes of Self-Assessment in the Inquiry Classroom
Eric M. Eslinger, University of Delaware
Joseph A. Brobst, University of Delaware

S8.4.2 Can Learning with Presented and Self-Constructed Visualizations Improve Students Learning from Science Text?
Annett Schwamborn, University of Duisburg-Essen
Hubertina Thillmann, University of Bochum
Claudia Leopold, University of Münster
Elke Sumfleth, University of Duisburg-Essen
Detlev Leutner, University of Duisburg-Essen

S8.4.3 Examining Patterns of Visual Representation Use in Middle School Science Classrooms
Victor R Lee, Utah State University

S8.4.4 How Does Limiting Students' Experimental Trials Affect Their Planning, Strategies, and Learning Outcomes?
Kevin W. McElhaney, University of California, Berkeley
Marcia C. Linn, University of California, Berkeley

Strand 3: Science Teaching--Primary School (Grades preK-6): Characteristics and Strategies

S8.5 SC-Paper Set: The Use of Dialogue and Questioning to Promote Learning in Primary Science
8:30am – 9:45am, Garden 2
Presider: Christina Fox Call, Brigham Young University

S8.5.1 "More Table, Less Carpet!": The Transformative Role of Cogenerative Dialogue And Video Analysis on Science Teaching and Learning in the Elementary Classroom
Sonya N. Martin, Drexel University
Christina Siry, CUNY

S8.5.2 Sociocultural Influences on Primary Science Pedagogy: A Multilevel Analysis of the Effect of Questions/Questioning
Diane P. Harris, University of Manchester, UK
Julian S. Williams, University of Manchester, UK

S8.5.3 Data and Claim: The Refinement of Science Fair Work Through Argumentation
Jian-Jung Chen, National Dong Hwa University, Taiwan
Huann-Shyang Lin, National Sun Yat-sen University, Taiwan
Ying-Shao Hsu, National Taiwan Normal University
Huei Lee, National Dong Hwa University, Taiwan

S8.5.4 The Impact of Technology-Enhanced Instruction on English Language Learners' Science Learning
Kihyun Ryoo, Stanford University

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies
S8.6 Strand Invited Symposium: Inquiry Science Instruction or Direct? Experiment-Based Answers as to what Practices Best Promote Conceptual Development of Significant Science Content
8:30am – 9:45am, Salon III
Presider: Penny Gilmer, Florida State University
Discussant: Cathleen C. Loving, Texas A&M University
Presenters: William W. Cobern, Western Michigan University
David Schuster, Western Michigan University
Reneé S. Schwartz, Western Michigan University
Janice D. Gobert, Worcester Polytechnic Institute

Strand 5: College Science Teaching and Learning (Grades 13-20)

S8.7 Related Paper Set: Mutually Exclusive to Synergistic: Factors Affecting Integration of Teaching and Research in Higher Education Faculty and Graduate Students
8:30am – 9:45am, Salon IV
Presider: David Feldon, Washington State University

S8.7.1 The Great Debate: The Value of Teaching and Research in Graduate Student Research Skill Development
Denise C. Strickland, University of South Carolina
Briana E. Timmerman, University of South Carolina
Michelle Maher, University of South Carolina
David Feldon, Washington State University

S8.7.2 Do Research Experiences Enhance the Inquiry-Oriented Teaching Skills of STEM Graduate Students?
Cindy Stiegelmeyer, University of South Carolina
David Feldon, Washington State University

S8.7.3 Exploring the Professional Identity Formation of Teachers
Joanna Gilmore, University of South Carolina
Melissa Hurst, University of South Carolina
Michelle Maher, University of South Carolina

S8.7.4 Exploring the Professional Identity Formation of Researchers
Melissa Hurst, University of South Carolina
Joanna Gilmore, University of South Carolina

S8.7.5 Finding Connections between STEM Graduate Students' Teaching and Research Identities and Skill Sets
Michelle Maher, University of South Carolina
David Feldon, Washington State University

Strand 6: Science Learning in Informal Contexts
S8.8 SC-Paper Set: Scientists, Citizens, and Learning Science Beyond School
8:30am – 9:45am, Salon V
Presider: Heather Zimmerman, Pennsylvania State University

S8.8.1 Reflections of Scientists and Engineers: Developing a Sense of Scale
M. Gail Jones, NC State University
Amy R.Taylor, University of NC at Wilmington

S8.8.2 Citizen Science: Positioning the Citizen in Environmental Monitoring and Informal Science
Carol B. Brandt, Virginia Polytechnic Institute & State University
Jane Lehr, California Polytechnic State University
Nancy McCrickard, Virginia Polytechnic Institute & State University

S8.8.3 Identity and Science Learning in Informal Learning Environments
Sylvia M. James, National Science Foundation
Karen Benn Marshall, Montgomery College

S8.8.4 Scientific Literacy: College Student's Evaluations of Scientific Media Reports
Cassandra A. Jones, Grande Prairie Regional College
Connie Korpan, Grande Prairie Regional College

Strand 7: Pre-service Science Teacher Education

S8.9 SC-Paper Set: The Role of Identity and Emotions in Preservice Teacher Education
8:30am – 9:45am, Salon II
Presider: Christina Schwarz, Michigan State University

S8.9.1 Ways of Knowing Science: Identity Development in Prospective Elementary Teachers
Laura L. Creighton, Rhode Island College

S8.9.2 Retrospective Testing and Science Teaching Self-Efficacy: The Influence of Context
Richard P. Hechter, University of North Dakota

S8.9.3 Pre-service Elementary Teachers' Anxiety about Teaching Science: What are the Triggers?
Nejla Yuruk, Gazi University
Pinar Akgul, Gazi University
Meryem Demir, Gazi University

S8.9.4 The Emotional Ecology of Becoming an Urban Science Teacher: Intersections between Identity, Emotions, and Explicit and Implicit Motivation
Maria S. Rivera Maulucci, Barnard College, Columbia University

S8.9.5 Examination of a New Model of Science Teacher Identity (STI) among Pre-Service Science Teachers
Hyun Jung Chi, The Ohio State University
David L. Haury, The Ohio State University

Strand 8: In-service Science Teacher Education

S8.10 SC-Paper Set: Early Career and Mentoring
8:30am – 9:45am, Salon I
Presider: Donna Sterling, George Mason University

S8.10.1 Mentoring New Mentors: Classroom-Based Learning Experiences For Science Teachers
Rebecca M. Schneider, The University of Toledo

S8.10.2 Increasing the Efficacy, Instructional Skills, and Effectiveness of New Science Teachers: What the Data Tell Us Works
Donna R. Sterling, George Mason University
Wendy M. Frazier, George Mason University
Mollianne G. Logerwell, George Mason University

S8.10.3 Linking Teacher Outcomes to Learning Opportunities in a Science Teacher Induction Program
Jamie N. Mikeska, Michigan State University
Jeffrey J. Rozelle, Michigan State University
Jodie A. Galosy, Michigan State University
Suzanne M. Wilson, Michigan State University

S8.10.4 Enactment of Reform in Induction: Changes in Beginning Science Teachers' Self-Efficacy Beliefs and Pedagogical Discontentments
Yavuz Saka, Florida State University
Sherry A. Southerland, Florida State University
Barry W. Golden, Florida State University

Strand 8: In-service Science Teacher Education

S8.11 SC-Paper Set: Approaches to Continuing of PD
8:30am – 9:45am, Salon VI
Presider: James G. MaKinster, Hobart and William Smith Colleges

S8.11.1 Project SLICE: Science Learning Through Inquiry, Content, and Engagement
Norman G. Lederman, Illinois Institute of Technology
Judith S. Lederman, Illinois Institute of Technology
Gary M. Holliday, Illinois Institute of Technology
Kevin J. White, Illinois Institute of Technology

S8.11.2 New Approaches to Primary Science Teaching and Assessment (NAPSTA) CPD Programme
Karen M. Kerr, St. Marys University College Belfast
Colette Murphy, Queens University Belfast
Jim Beggs, St. Marys University College Belfast

S8.11.3 Teaching and Learning Science with Geospatial Technology: The Impact of Flexibly Adaptive, Long-Term Professional Development on Teachers and Students
James G. MaKinster, Hobart and William Smith Colleges
Nancy M. Trautmann, Cornell University

S8.11.4 Building Science Content Knowledge through Sustained Professional Development
Kimberly A. Lebak, The Richard Stockton College of New Jersey
Norma J. Boakes, The Richard Stockton College of New Jersey

Strand 9: Reflective Practice
S8.12 SC-Paper Set: Reflective Practice
8:30am – 9:45am, Grand Ballroom G
Presider: Erin Peters, George Mason University

S8.12.1 Professional Development through Action Research: The Development and Use of a Learning Environment Questionnaire as a Tool for Reflection
David Wood, Curriculum Council of Western Australia
Jill M. Aldridge, Curtin University of Western Australia
Barry J. Fraser, Curtin University of Western Australia

S8.12.2 Prototypical Routines of Biology Teachers
Martin Linsner, University of Duisburg-Essen, Germany
Philipp Schmiemann, University of Duisburg-Essen, Germany
Angela Sandmann, University of Duisburg-Essen, Germany
Birgit J. Neuhaus, Ludwig-Maximilian-University of Munich, Germany

S8.12.3 Enacting Reflections on Practice in Preservice Science Middle School Teachers
Teresa Jimarez, Texas A & M Universty

S8.12.4 Using Cogenerative Dialogues to Facilitate Agency in Science Methods Courses
Line A. Augustin, Queens College City University of New York

Strand 10: Curriculum, Evaluation, and Assessment

S8.13 SC-Paper Set: Validity and Absence-of-Bias of Standardized Measurement Instruments
8:30am – 9:45am, Garden 4
Presider: Avi Hofstein, Weizmann Institute of Science, Israel

S8.13.1 Rising Questions of Validity of Translated Science Units from PISA
Alice M. Rodrigues, University of Lisbon
Mauricia M. Oliveira, University of Lisbon

S8.13.2 Exploring Differential Item Functioning (DIF) in the Measurement of Student Knowledge and Misconceptions of Natural Selection
Ross H. Nehm, The Ohio State University
Judy Ridgway, The Ohio State University
William Boone, Miami University

S8.13.3Evidence of Student Thinking in the Validation of Science Assessment Items: Confirming Student Idea Use
Robert J. Ochsendorf, George Washington University

S8.13.4 Considering Construct Validity in Assessment Construction: The Case of the Test of Astronomy Standards (TOAST)
Stephanie J. Slater, University of Wyoming
Timothy F. Slater, University of Wyoming

Strand 11: Cultural, Social, and Gender Issues

S8.14 SC-Paper Set: Learning to Participate and Engage in Science Practices
8:30am – 9:45am, Salon VII
Presider: Rhea Miles, East Carolina University

S8.14.1 Investigating Student Engagement, Thinking, and Learning in Science – Findings from a Yearlong, Inquiry-Based Teaching Experience
Sybil S. Kelley, Portland State University
Dalton Miller-Jones, Portland State University
William G. Becker, Portland State University

S8.14.2 The Influence of Gender, Context, and Racial Self-Concept on African American Early Adolescents' Motivation to Engage in Science Literacy Practices
Tanya Cleveland Solomon, University of Michigan

S8.14.3 Cultural Aspects of Argumentation and the Implications for Engaging Youth with What it Means to Argue Scientifically
Leah A. Bricker, Loyola University Chicago

S8.14.4 From a "Hybrid Discourse" towards "Legitimate Peripheral Participation"
Hayat F. Hokayem, Michigan State University
Angela Calabrese Barton, Michigan State University

Strand 12: Educational Technology

S8.15 SC-Paper Set: How do Computer Simulations Enhance Teaching and Learning?
8:30am – 9:45am, Salon VIII
Presider: Keisha Varma, University of Minnesota

S8.15.1 The Use of a Computer Simulation to Promote Conceptual Change: A Quasi-Experimental Study
Randy L. Bell, University of Virginia
Kathy Cabe Trundle, The Ohio State University

S8.15.2 Incorporation of Computer Simulations in Whole-class Vs. Small-group Settings
Lara K. Smetana, Southern Connecticut State University
Randy L. Bell, University of Virginia

S8.15.3 What You See Is Not Always What You Get: Using Digital Video Technology to Research the Preservice Preparation of Elementary Science Teachers
Paul Bueno de Mesquita, University of Rhode Island
Ross F. Dean, University of Rhode Island
Betty J. Young, University of Rhode Island

S8.15.4 Instructional Support for Learning with Computer Simulations about the "Ecosystem Water"
Marc Eckhardt, University of Kiel
Detlef Urhahne, University of Munich
Olaf Conrad, University of Hamburg
Ute Harms, University of Kiel

Strand 13: History, Philosophy, and Sociology of Science

S8.16 SC-Paper Set: Representations of Science in Practice, Writing, and Textbooks
8:30am – 9:45am, Garden 1
Presider: Valarie L. Akerson, Indiana University

S8.16.1 Understanding Differences in Scientific Methodology via Language Analysis
Jeff Dodick, The Hebrew University of Jerusalem, Israel
Shlomo Argamon, Illinois Institute of Technology
Paul Chase, Illinois Institute of Technology

S8.16.2 A Longitudinal Analysis of the Representations of Nature of Science in High School Biology and Physics Textbooks
Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign
Nader Wahbeh, University of Illinois at Urbana-Champaign
Noemi Waight, State University of New York at Buffalo
Ava Zeineddin, Wayne State University

S8.16.3 The Empirical Attitude, Material Practice, and Design Activities
Xornam Apedoe, University of San Francisco
Michael Ford, University of Pittsburgh

S8.16.4 Junior Chemists' Understanding of the Nature of Scientific Theories and Laws
Frackson Mumba, Southern Illinois University
Jeffrey Carver, West Virginia University
Vivien Chabalengula, Southern Illinois University
William J.F. Hunter, Illinois State University

Strand 15: Policy

S8.17 Strand Invited Symposium: Quality Research, Policy, and Practice in Service of Science Education: Part 1-Principles and Procedures
8:30am – 9:45am, Grand Ballroom E
Presider: Yehudit Judy Dori, Israel Institute of Technology/MIT
Discussants: Doris Jorde, University of Oslo, Norway
Richard A. Duschl, Pennsylvania State University
Presenters: Stephen P. Norris, University of Alberta, Canada
Linda M. Phillips, University of Alberta, Canada
Richard K. Coll, University of Waikato, New Zealand
Hsiao-Ching She, National Chiao Tung University, Taiwan
Mack C. Shelley II, Iowa State University
Larry D. Yore, University of Victoria, Canada
Brian Hand, University of Iowa

Break
9:45am – 10:15am

Concurrent Session #9
10:15am – 11:45am

Research Committee Sponsored Session

S9.1 Symposium: Scale-Up Research in Science Education: A Grand Challenge for Science Education or Grand Delusion?
10:15am – 11:45am, Grand Ballroom D
Presider: Janice Earle, National Science Foundation
Presenter: Sharon J. Lynch, George Washington University
Nancy Butler Songer, University of Michigan
Michael R. Vitale, East Carolina University
Nancy R. Romance, Florida Atlantic University
Bill Watson, George Washington University
Curtis Pyke, George Washington University

Research Committee Sponsored Session

S9.2 Technology Symposium: Higher Education Opportunities with Apple Computer Inc.
10:15am – 11:45am, Pacific Room
Rae Niles, Apple Computer Inc.

Strand 1: Science Learning, Understanding and Conceptual Change

S9.3 SC-Paper Set: Representing Matter II
10:15am – 11:45am, Grand Ballroom F
Presider: Ann Wright

S9.3.1 The Impact of Curriculum on Conceptual Understanding and Theoretical Framework
Sharon P. Schleigh, East Carolina University

S9.3.2 Using a Nanoscience Context to Develop and Evaluate Student Conceptions of the Relationships among Observations of Materials and their Particulate Explanations
Clara S. Cahill, University of Michigan
Joseph Krajcik, University of Michigan

S9.3.3 Patterns of Progression in Students' Understanding of Combustion
Chih-Che Tai, Columbia University
Keith Sheppard, Stony Brook University

S9.3.4 Physics Students' Mental Models of Thermal Conduction: Their Emerging Cognitive Representations of the Dynamic Processes and Their Resulting Predictions
Guo-Li Chiou, Columbia University
O. Roger Anderson, Columbia University

Strand 1: Science Learning, Understanding and Conceptual Change

S9.4 Symposium: Coherence and Science Content Storylines in Science Teaching: Evidence of Neglect? Evidence of Effect?
10:15am – 11:45am, Grand Ballroom G
Kathleen J. Roth, LessonLab Research Institute
Meike Lemmens, LessonLab Research Institute
Helen E. Garnier, LessonLab Research Institute
Catherine Chen, LessonLab Research Institute
Nicole I. Z. Wickler, California State Polytechnic University, Pomona
Jo Ellen Roseman, AAAS Project 2061
Angela Calabrese Barton, Michigan State University
Carla Zembal-Saul, Pennsylvania State University
Leslie J. Atkins, California State University, Chico
Andrew W. Shouse, University of Washington

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S9.5 SC-Paper Set: Epistemological Beliefs and Perceptions in Learning Scientific Phenomena
10:15am – 11:45am, Garden 2
Presider: Sean Smith, Horizon Research, Inc.

S9.5.1 Students' and Teachers' Conceptions of Surface Area to Volume in Science Contexts: What Factors Influence the Understanding of the Concept of Scale?
Amy R. Taylor, University of North Carolina Wilmington
M. Gail Jones, North Carolina State University

S9.5.2 Personal Epistemological Belief Changes in a Chemistry Laboratory Environment
Linda Keen-Rocha, University of South Florida
Dana Zeidler, University of South Florida

S9.5.3 Quantifying High School Students' Self-Perceptions in Learning Chemistry
Murat Kahveci, Canakkale Onsekiz Mart University, Turkey

S9.5.4 Response Characteristics of Middle School Learners' Critiques of Nanoscale Phenomena Representations
Tom Moher, University of Illinois
Brenda López Silva, University of Illinois at Chicago
Shanna Daly, Purdue University
Marco Bernasconi, University of Illinois

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S9.6 Related Paper Set: Affective Learning Environments: Opportunities for Complexity Thinking in Science Education
10:15am – 11:45am, Garden 3
Presider: Rachel F. Moll, University of British Columbia

S9.6.1 Complexity Thinking in Science Education: A Theoretical Framework and Applications
Rachel F. Moll, University of British Columbia
Jeff J. Baker, University of British Columbia

S9.6.2 Emergence of Metacognitive Awareness in a Complex Learning System
Wendy Nielsen, University of British Columbia

S9.6.3 A Complex View of Science Learning
Anne Fiona White, York University
Sheliza Ibrahim, York University
Steve Alsop, York University

S9.6.4 A Field Zine to Science and the City: Remembering Community Interactions and Place-Based Projects
Sheliza Ibrahim, York University
Melissa Blimkie, York University
Anne Fiona White, York University
Steve Alsop, York University

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies

S9.7 SC-Paper Set: Secondary Science Teachers' Perspectives about Learning and Instruction
10:15am – 11:45am, Salon III
Presider: Anita Welch, North Dakota State University

S9.7.1 The Influence of Teacher Education on Prospective Science Teachers' Rationales for Instructional Activity Selections
Debra Tomanek, University of Arizona
Ingrid Novodvorsky, University of Arizona
Vicente Talanquer, University of Arizona

S9.7.2 Teacher Noticing In-the-Moment of Instruction: The Case of One High-School Science Teacher
Melissa J. Luna, Northwestern University
Rosemary S. Russ, Northwestern University
Adam Colestock, Northwestern University

S9.7.3 One-On-One Science Instruction
Rhea L. Miles, East Carolina University

Strand 5: College Science Teaching and Learning (Grades 13-20)

S9.8 SC-Paper Set: Biology and Chemistry: Instruction and Assessment
10:15am – 11:45am, Salon IV
Presider: Penny J. Gilmer, Florida State University

S9.8.1 Model-based Inquiry as a Context for Supporting Undergraduates' Epistemic Resources
Julia Svoboda, University of California, Davis
Cynthia Passmore, University of California, Davis

S9.8.2 Student Learning with the Case Study Method of Instruction
Kathy K. Gallucci, Elon University

S9.8.3 Cognitive Task Analysis as a Basis for Instruction in Experimental Design and Analysis: Impacts on Skill Development and Student Retention in the Biological Sciences
David F. Feldon, Washington State University
Kirk A. Stowe, University of South Carolina
Richard Showman, University of South Carolina

S9.8.4 Using Lexical Analysis Software to Understand Student Knowledge Transfer between Chemistry and Biology
Kevin C. Haudek, Michigan State University
Rosa A. Moscarella, Michigan State University
Mark Urban-Lurain, Michigan State University
John Merrill, Michigan State University
Ryan D. Sweeder, Michigan State University
Gail Richmond, Michigan State University

Strand 7: Pre-service Science Teacher Education

S9.9 SC-Paper Set: Preservice Teachers' Perceptions of the Nature of Science
10:15am – 11:45am, Salon II
Presider: Meredith Park Rogers, Indiana University

S9.9.1 Preservice Science Teachers' Informal Reasoning Regarding Socioscientific Issues and the Factors Influencing Their Informal Reasoning
Mustafa S. Topcu, Yüzüncu Yýl University
Ozgul Yilmaz-Tuzun, Middle East technical University
Troy D. Sadler, University of Florida

S9.9.2 Examining the Efficacy of an Explicit and Reflective Course on the Development of Preservice Secondary Science Teachers' Conceptions of Nature of Science
Ron E. Gray, Oregon State University
Nam-Hwa Kang, Oregon State University

S9.9.3 Developing Pedagogical Content Knowledge for Teaching the Nature of Science: Lessons from a Mentor-Mentee Relationship
Deborah Hanuscin, University of Missouri
Jane Hian, Hallsville School District, Missouri

S9.9.4 Elementary Teachers' Views on the Nature of Science: A Comparison of Inservice and Preservice Teachers
Minsuk K. Shim, University of Rhode Island
Betty J. Young, University of Rhode Island
Judith Paolucci, Narragansett Schools

Strand 7: Pre-service Science Teacher Education

SC-Paper Set: Curriculum, Practice, and Instruction
10:15am – 11:45am, Salon V
Presider: Amelia Gotwals, Michigan State University

S9.10 Preservice Elementary Teachers' Adaptation of Science Curriculum Materials and Development of Pedagogical Design Capacity for Inquiry-Oriented Science Teaching
Cory T. Forbes, University of Michigan
Elizabeth A. Davis, University of Michigan

S9.10.1 Guided Inquiry-Based Practical Work: The Possibilities of Inquiry In Everyday Elementary Science Classrooms
Mijung Kim, National Institute of Education, Singapore
Christine Chin, National Institute of Education, Singapore

S9.10.2 Swirling Discourses: Using a Discourses and Communities Framework to Situate Elementary Preservice Teachers' Use of an Instructional Model to Plan and Teach Science
Kristin L. Gunckel, University of Arizona

S9.10.3 Content-Area Literacy in New Teachers' Secondary Science Classrooms: Challenges and Possibilities
Ann E. Rivet, Teachers College Columbia University
Audrey Rabi Whitaker, Columbia University

Strand 8: In-service Science Teacher Education

S9.11 SC-Paper Set: Teaching in Context
10:15am – 11:45am, Salon I
Presider: Doris Elster, University of Kiel

S9.11.1 Changing the Way of Teaching through Professional Development in Learning Communities: The "Biology in Context" Program
Doris Elster, University of Kiel
Lücken Markus, University of Kiel

S9.11.2 The Impact of a Teacher Professional Development Workshop on Perceptions of Design, Engineering, and Technology Activities for Integrated Curriculum
Karen A. High, Oklahoma State University
Pasha D. Antonenko, Oklahoma State University
Susan L. Stansberry, Oklahoma State University
Rebecca L. Damron, Oklahoma State University
Gayla J. Hudson, Oklahoma State University
Jean E. Dockers, Oklahoma State University
Alonzo F. Peterson, Langston University

Strand 8: In-service Science Teacher Education
S9.12 SC-Paper Set: Enacting Reform
10:15am – 11:45am, Salon VI
Presider: Barry W. Golden, Florida State University

S9.12.1 Use of Children's Literature by K-12 Teachers in a Science Inquiry Unit
Susannah K. Sandrin, UW Oshkosh
John Lemberger, UW Oshkosh
Peter M. Meyerson, UW Oshkosh

S9.12.2 Lesson Plans and Science Education Reform: Is there a Connection?
Barry W. Golden, Florida State University
Yavuz Y. Saka, Florida State University
Patrick J. Enderle, Florida State University
Sherry A. Southerland, Florida State University

S9.12.3 Understanding the Process of Applying Inquiry Teaching Methods in Elementary Classrooms
Michele J. Hollingsworth Koomen, Gustavus Adolphus College
High School Science Teachers' First Experience Teaching ELLs: A Year-Long Multiple Case Study
Karleen R. Goubeaud, Long Island University

Strand 10: Curriculum, Evaluation, and Assessment

S9.13 Strand Invited Symposium: International Perspectives on Impacts of National Science Content Standards on Science Curriculum and Assessment Practices
10:15am – 11:45am, Garden 4
Presider: Xiufeng Liu, State University of New York at Buffalo
Discussants: David F. Treagust, Curtin University of Technology, Australia
Larry D. Yore, University of Victoria, Canada
John A. Anderson, University of Victoria, Canada
Todd M. Milford, University of Victoria, Canada
Justin Dillon, King's College London
Angelo Collins, Knowles Science Teaching Foundation

Strand 11: Cultural, Social, and Gender Issues

S9.14 SC-Paper Set: Mentoring, Socialization, and Career Pathways
10:15am – 11:45am, Salon VII
Presider: Christine Reyes

S9.14.1 Coteaching as Engaged Pedagogy: Transforming Science Teacher Education through Shared Responsibility
Christina Siry, CUNY
Sonya N. Martin, Drexel University

S9.14.2 Crafts(wo)men and Guilds: Expertise Development Among Science Education Researchers
John Settlage, University of Connecticut
Adam Johnston, Weber State University
Julie Kittleson, University of Georgia

S9.14.3 Eye of the Beholder: Gender and Perceptions of Mentoring in Science Education
Susan A. Nolan, Seton Hall University
Cecilia H. Marzabadi, Seton Hall University
Janine P. Buckner, Seton Hall University

S9.14.4 Sustaining Women in Physics, Chemistry, Mathematics, and Computer Science through Graduation
Barbara A. Burke, California State Polytechnic University
Dennis W. Sunal, University of Alabama

Strand 12: Educational Technology

S9.15 SC-Paper Set: Cognitive and Attitudinal Impacts of Virtual Learning Experiences
10:15am – 11:45am, Salon VIII
Presider: Andrew Zucker, The Concord Consortium, Concord, MA

S9.15.1 Measured and Perceived Cognitive and Motivational Effects of a Virtual Scientist Mentor
Catherine D. Bowman, Raytheon/NASA Ames Research Center
Diane Jass Ketelhut, Temple University

S9.15.2 Analyzing Predictors of Learning through Student Self-Efficacy in a Technology-Based Project
Len A. Annetta, North Carolina State University
Shawn Y. Holmes, North Carolina State University
Meng-Tzu Cheng, North Carolina State University
Elizabeth Folta, North Carolina State University
James A. Shymansky, University of Missouri
Richard Lamb, North Carolina State University

S9.15.3 Real Conversations in Virtual Worlds: The Impact of Student Conversations on Understanding of Science
Janice L. Anderson, University of North Carolina

S9.15.4 The Impact of Domain Knowledge on the Portability of Vicarious Learning to the Classroom
Scotty D. Craig, University of Memphis
Joshua K. Brittingham, University of Memphis
Joah L. Williams, University of Memphis
Trey Martindale, University of Memphis
Arthur C. Graesser, University of Memphis
Barry Gholson, University of Memphis

Strand 13: History, Philosophy, and Sociology of Science

S9.16 SC-Paper Set: Preparing Teachers to Meet Standards for Nature of Science and Inquiry
10:15am – 11:45am, Garden 1
Presider: John Bencze, University of Toronto

S9.16.1 Linking Teachers' Understandings of Nature of Science and Scientific Inquiry with Instructional Ability: A Follow-Up Investigation

Judith S. Lederman, Illinois Institute of Technology
Kevin J. White, Illinois Institute of Technology
Norman G. Lederman, Illinois Institute of Technology

S9.16.2 Overcoming the Difficulties of Inquiry through Coaching

Rudolf V. Kraus, Rhode Island College
Norman G. Lederman, Illinois Institute of Technology

S9.16.3 A Critical Review of Current U.S. State Science Standards with Respect to the Inclusion of Elements of the Nature of Science

William F. McComas, University of Arkansas
Carole K. Lee, University of Arkansas
Sophia J. Sweeney, University of Arkansas

S9.16.4 Modeling Epistemic Practices in Science Teachers' Learning

Sibel Erduran, University of Bristol

Strand 15: Policy:
S9.17 Strand Invited Symposium: Quality Research, Policy, and Practice in Service of Science Education: Part 2-Lessons Learned
10:15am – 11:45am, Grand Ballroom E

Presider: Brian Hand, University of Iowa

Discussants: Stephen P. Norris, University of Alberta, Canada
Linda M. Phillips, University of Alberta, Canada
Richard K. Coll, University of Waikato, New Zealand

Presenters: Yehudit Judy Dori, Israel Institute of Technology
Doris Jorde, University of Oslo, Norway
Jonathan Osborne, Stanford University
Richard A. Duschl, Pennsylvania State University
Marissa Rollnick, Witswatersrand University, South Africa
Hsiao-Ching She, National Chiao Tung University, Taiwan

Lunch: On your own
12:00pm – 12:45pm

Concurrent Session #10
1:00pm – 2:30pm

External Policy Sponsored Session

S10.1 Symposium: Part I-Math Science Partnerships (MSPs): Rising to the Grand Challenges of Bringing Contemporary Science to K-12 Teachers and Students and Providing Evidence of Impact
Focus: Goals of MSPs from Federal Policy Standpoints, and Panel Presentations on Individual MSPs and Outcomes.
1:00pm – 2:30pm, Grand Ballroom D
Presiders: Sharon Lynch, George Washington University
Andrew Shouse, University of Washington-Seattle
Discussants: Kathleen Bergin, National Science Foundation
Pat Johnson, United States Department of Education
Presenters: Amy Edmondson, Centralia Elementary School District (California)
Terry L. McCollum, Miami University (Ohio)
George Nelson, Western Washington University
Carolyn Landel, Western Washington University
Bill Schmidt, Michigan State University

Research Committee Sponsored Session

S10.2 Technology Symposium: Science Education for a Global Future: Why Aren't American Schools Measuring Up and What Can We Do About It?
1:00pm – 2:30pm, Pacific Room
Nancy Butler Songer, University of Michigan
Lea Bullard, University of Michigan
Tricia Jones, University of Michigan

Strand 1: Science Learning, Understanding and Conceptual Change

S10.3 SC-Paper Set: Understanding Space at the Elementary Level
1:00pm – 2:30pm, Grand Ballroom F
Presider: David Feldon, Washington State University

S10.3.1 Comparing the Efficacy of Reform Based and Traditional/Verification Curricula to Support Student Learning About Space Science
Ellen Granger, Florida State University
Todd H. Bevis, Florida State University
Yavuz Saka, Florida State University
Sherry Southerland, Florida State University

S10.3.2 Children Explaining Celestial Motion: Development of a Learning Progression
Julia D. Plummer, Arcadia University
Cynthia Slagle, Colonial School District

S10.3.3 Conceptual Understandings of Middle School Students' with Visual Impairments Concerning Seasonal Change
Tiffany Wild, The Ohio State University
Kathy Cabe Trundle, The Ohio State University

S10.3.4 A Three Year Longitudinal Study of Elementary Students' Understandings of Lunar Concepts Related to Moon Phases
Timothy R. Young, University of North Dakota
Mark D. Guy, University of North Dakota

Strand 1: Science Learning, Understanding and Conceptual Change

S10.4 Symposium: Argumentation in Science Education: Current Challenges and Future Directions
1:00pm – 2:30pm, Grand Ballroom G
Presider: Jonathan F. Osborne, Stanford University
Presenters: Joseph Krajcik, University of Michigan
Katherine McNeill, Boston College
Douglas Clark, Arizona State University
Muhsin Menekse, Arizona State University
Cynthia DAngelo, Arizona State University
Sharon Schleigh, East Carolina University
Maria Evagorou, Kings College London

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S10.5 SC-Paper Set: Teaching and Learning Chemistry: Lessons from the Field
1:00pm – 2:30pm, Garden 2
Presider: Victor Sampson, Florida State University

S10.5.1 Chemistry, Inquiry, and Distance Learning Do Mix! Learners Working as Scientists in an Online Course for Teachers
Mary V. Mawn, SUNY Empire State College

S10.5.2 The Challenge of Teaching Chemistry Contextually: Achieving Resonance between Classroom Transactions and Real-World Fields
Donna T. King, Queensland University of Technology
Stephen M. Ritchie, Queensland University of Technology

S10.5.3 Efficiency of Tasks in Chemistry Lessons
Oliver Tepner, University of Duisburg-Essen
Burkhard Roeder, University of Dortmund
Insa Melle, University of Dortmund

S10.5.4 Exploring the Impact of Differing Participant Structures in the Chemistry Classroom
Dennis W. Smithenry, Santa Clara University

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S10.6 Symposium: What about Love? The Role of Emotions in Urban Science Education
1:00pm – 2:30pm, Garden 3
Presider: Karen E. S. Phillips, CUNY
Presenters: Christina Siry, CUNY
Maria S. Rivera Maulucci, Columbia University
Nicole Grimes, CUNY

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies

S10.7 SC-Paper Set: Pedagogical Content Knowledge in Secondary Science
1:00pm – 2:30pm, Salon III
Presider: Michiel van Eijck, Eindhoven University of Technology, The Netherlands

S10.7.1 Middle Grade Teachers Characterizations of Integrated Mathematics and Science Instruction
James Stallworth, University of Cincinnati
Helen Meyer, University of Cincinnati
Shelly Harkness, University of Cincinnati
Kevin Stinson, University of Cincinnati

S10.7.2 The First Three Years: How Context and Pedagogical Content Knowledge Affects the Use of Instructional Materials and Resources
Krista L. Adams, Arizona State University
Jonah B. Firestone, Arizona State
Julie A. Luft, Arizona State University
Jennifer J. Neakrase, New Mexico State University
EunJin Bang, Iowa State University University
Irasema Ortega, Arizona State University
Sissy Wong, Arizona State University

S10.7.3 A Comparison of Teachers' Demonstration of Pedagogical Content Knowledge While Planning In and Out of Their Science Expertise
Jenny D. Ingber, Columbia University
Ann E. Rivet, Columbia University

S10.7.4 Pedagogical Content Knowledge in High School Chemistry: Teacher Efficacy, High Stakes Standardized Testing, and Student Outcomes
Angela M. Kelly, City University of New York
Lauren Marcinowski, City University of New York
Ari Leventhal, City University of New York

Strand 5: College Science Teaching and Learning (Grades 13-20)

S10.8 SC-Paper Set: Chemistry, Thought, Pedagogy, and Curriculum
1:00pm – 2:30pm, Salon IV

S10.8.1 Teaching Quantum Mechanical Concepts via the Learning Unit "From Nano-Scale Chemistry to Microelectronics"
Vered Dangur, Technion - Israel Institute of Technology
Uri Peskin, Technion - Israel Institute of Technology
Yehudit Judy Dori, Technion - Israel Institute of Technology

S10.8.2 College Students' Use of Learning Strategies and Their Anxiety Levels in Chemistry
Betul Demirdogen, Zonguldak Karaelmas University
Esen Uzuntiryaki, Middle East Technical University
Yesim Capa Aydin, Middle East Technical University

S10.8.3 An Exploration of Practitioner Development in Organic Chemistry: The Role of Reaction Mechanism Problem-Solving Skills
Jason P. Anderson, Purdue University
George M. Bodner, Purdue University

S10.8.4 Constrained Reasoning: Mental Shortcuts Used by Chemistry Students
Jenine Maeyer, University of Arizona.
Vicente Talanquer, University of Arizona.

Strand 6: Science Learning in Informal Contexts

S10.9 SC-Paper Set: Examining Learning in Exhibitions
1:00pm – 2:30pm, Salon V
Presider: Lynn Dierking, Oregon State University

S10.9.1 Learning as a Family at the Zoo
Loran C. Parker, Purdue University
Gerald H. Krockover, Purdue University

S10.9.2 Measuring Emotion at an Urban Science Center
Katie L. Gillespie, Oregon State University
John H. Falk, Oregon State University

S10.9.3 Accessing and Incorporating Visitors' Entrance Narratives Enhances Guided Museum Tours
Dina Tsybulskaya, The Hebrew University of Jerusalem, Israel
Jeff Dodick, The Hebrew University of Jerusalem, Israel
Jeff Camhi, The Hebrew University of Jerusalem, Israel

S10.9.4 How Does Content Delivered Via Handheld Computers Mediate Visitors' Action at an ISEA?
Molly E. Phipps, Science Museum of Minnesota

S10.9.5 Macro-Scale Structure of Activity Aquarium Touch Tanks: Examining Visitor Engagement through Talk and Action
Shawn M. Rowe, Oregon State University
James Kisiel, California State University, Long Beach

Strand 7: Pre-service Science Teacher Education

S10.10 SC-Paper Set: The Development of Pedagogical Content Knowledge in Preservice Teachers
1:00pm – 2:30pm, Salon II
Presider: Elizabeth Davis, University of Michigan

S10.10.1 Improving Preservice Science Teacher Education at University by Means of Special Exercise Tasks – An Attempt Based on Generative Learning Theory
Michael Germ, Ludwig Maximilians University of Munich, Germany
Andreas Mueller, University of Koblenz-Landau, Germany
Ute Harms, University of Kiel, Germany

S10.10.2 Developing Technological Pedagogical Content Knowledge (TPCK) of Pre-Service Science Teachers through a Peer Coaching Model
Syh-Jong Jang, Chung-Yuan Christian University, Taiwan

S10.10.3 Preservice Teachers' Topic-Specific Pedagogical Content Knowledge for Teaching the Concept of Dissolving
Karthigeyan Subramaniam, Pennsylvania State University

S10.10.4 Changes in Beginning Secondary Science Teachers' PCK for Instruction
Mark J. Volkmann, University of Missouri, Columbia
Patrick L. Brown, Washington University, Missouri
Andrew B. West, University of Missouri, Columbia
Deanna M. Lankford, University of Missouri, Columbia
Sandra K. Abell, University of Missouri, Columbia

Strand 8: In-service Science Teacher Education

S10.11 SC-Paper Set: Efficacy of Professional Development
1:00pm – 2:30pm, Salon I
Presider: Jane Butler Kahle, Miami University

S10.11.1 Co-Evolution of Practice and Pedagogy: A Model for Science Teacher Change in the Context of Professional Development
Ian D. Beatty, University of Massachusetts Amherst and University of North Carolina at Greensboro
Allan Feldman, University of Massachusetts Amherst

S10.11.2 Is Science Inquiry Professional Development Effective? A Critical Review of Empirical Research
Daniel K. Capps, Cornell University
Barbara Crawford, Cornell University

S10.11.3 Sustaining Change: Are Booster Shots Needed?
Jane Butler Kahle, Miami University
Yue Li, Miami University
Kathryn Scantlebury, University of Delaware
Constance W. Blasie, University of Pennsylvania

S10.11.4 Can Science/Math Teachers Gain Their Inquiry Teaching Competence from Inservice Teacher Education
Hsiao-Lin Tuan, National Changhua University of Education, Taiwan
Chien-Chung Tseng, National Changhua University of Education, Taiwan
Meichun Lydia Wen, National Changhua University of Education, Taiwan
Erh-Tsung Chin, National Changhua University of Education, Taiwan
Kuo-Hua Wang, National Changhua University of Education, Taiwan

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Strand 10: Curriculum, Evaluation, and Assessment

S10.12 SC-Paper Set: Probing Student Understanding and Reasoning
1:00pm – 2:30pm, Garden 4
Presider: Bruce Waldrip, Monash University

S10.12.1 Ontology-Informed Diagnostic Assessment of Middle and Secondary Students' Understanding of the Particulate Nature of Matter
Ajda Kahveci, Marmara University
Dilek Ozalp, Marmara University

S10.12.2 Development and Pilot Testing of Ontology-Informed Distractor-Driven Diagnostic Instrument on the Particulate Nature of Matter
Dilek Ozalp, Marmara University
Ajda Kahveci, Marmara University

S10.12.3 Design Research on the Assessment of Geological Observation: The Components of Perception, Explanation, and Gestures
John Y. Baek, Oregon State University

S10.12.4 Using Content-Aligned Assessment to Probe Middle School Students' Understanding of Ideas about Energy
Cari F. Herrmann-Abell, Project 2061 / AAAS
George E. DeBoer, Project 2061 / AAAS

Strand 11: Cultural, Social, and Gender Issues

S10.13 SC-Paper Set: Revisiting Gender and Race in Science Education
1:00pm – 2:30pm, Salon VII
Presider: Carol Brandt, Virginia Polytechnic Institute & State University

S10.13.1 Awakening a Dialog: Examining Gender and Race in NOS Studies from 1967 to 2008
Leon Walls, Purdue University
Lynn A. Bryan, Purdue University

S10.13.2 Quantifying the Gender Gap in Science Interests
Ayelet Baram-Tsabari, Technion, Israel
Anat Yarden, Weizmann Institute of Science, Israel

S10.13.3 Exploring How Urban African-American Girls Position Themselves in Science Learning
Gayle Buck, Indiana University
Kristin Cook, Indiana University
Cassie Quigley, Indiana University
Jennifer Eastwood, Indiana University

Strand 11: Cultural, Social, and Gender Issues

S10.14 Symposium: Science, Science Education and the War on Terror
1:00pm – 2:30pm, Salon VIII
Presider: Matthew Weinstein, University of Washington-Tacoma
Discussants:
Wendy M. Frazier, George Mason University
Andy Johnson, Black Hills State University
Geeta Verma, Georgia State University

Strand 13: History, Philosophy, and Sociology of Science

S10.15 Symposium: Grand Challenge and Great Opportunity: Fully Taking the Practice Turn in Science Education with Respect to Scientific Work
1:00pm – 2:30pm, Garden 1
Presider: Philip Bell, University of Washington
Discussant: Reed Stevens, University of Washington
Presenters: Gregory J. Kelly, Penn State University
Wendy Newstetter, Georgia Institute of Technology
Leah A. Bricker, Loyola University Chicago

Strand 14: Environmental Education
S10.16 SC-Paper Set: The Impact of Socio-Cultural Factors on Environmental Education
1:00pm – 2:30pm, Salon VI
Presider: Tali Revital Tal, Technion - Israel Institute of Technology

S10.16.1 The Impact of Socio-environmental Projects of Jewish and Arab Youth in Israel
Iris Alkaher, Technion - Israel Institute of Technology
Tali Revital Tal, Technion - Israel Institute of Technology

S10.16.2 Science Education for the Environment - Cross-National Evidence Relating Science Performance to Environmental Attitudes
Jelle Boeve-de Pauw, University of Antwerp
Peter Van Petegem, University of Antwerp

S10.16.3 Science Learning in Confronting Environmental Lead Contamination
Jill C. McNew, Washington University in St. Louis

S10.16.4 An Investigation of Gender Effect on University Students' Environmental Reasoning Patterns toward Environmental Moral Dilemmas
Busra Tuncay, Giresun University
Ozgul Yilmaz Tuzun, Middle East Technical University
Cihan Gulin Cihangir, Giresun University

Strand 15: Policy

S10.17 Symposium: Challenges and Opportunities for Science Education in Arab States
1:00pm – 2:30pm, Grand Ballroom E

Presider: Saouma BouJaoude, American University of Beirut
Discussant: Justin Dillon, King's College London
Presenters: Zoubeida R. Dagher, University of Delaware
Ghada Gholam, UNESCO Cairo Office
Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign
Saouma BouJaoude, American University of Beirut
Nasser Mansour, University of Exeter

Break
2:30pm – 3:00pm

Concurrent Session #11
3:00pm – 4:30pm

External Policy Sponsored Session

S11.1 Symposium: Part II-Math Science Partnerships (MSPs): Rising to the Grand Challenges of Bringing Contemporary Science to K-12 Teachers and Students and Providing Evidence of Impact
Focus: Panel on How to Establish a MSP with Partner Institutions; Special Challenges and Lessons Learned; Panel and Audience Interaction
3:00pm – 4:30pm, Grand Ballroom D
Presiders: Sharon Lynch, George Washington University
Andrew Shouse, University of Washington-Seattle
Discussants: Kathleen Bergin, National Science Foundation
Pat Johnson, United States Department of Education
Presenters: Amy Edmondson, Centralia Elementary School District (California)
Terry L. McCollum, Miami University (Ohio)
George Nelson, Western Washington University
Carolyn Landel, Western Washington University
Bill Schmidt, Michigan State University

Research Committee Sponsored Session

S11.2 Technology Symposium: The Impact of Video Analysis on the Development of Professional Vision in Preservice and Practicing Teachers
3:00pm – 4:30pm, Pacific Room
Scott McDonald, Penn State University
Brett Criswell, Penn State University
Oliver Dreon, Millersville University
Steve Kerlin, Penn State University
Mark Merrit, Penn State University
Chris Ruggerio, Penn State University
Scott DeLone, Penn State University
Cecilia Tang, Penn State University

Strand 1: Science Learning, Understanding and Conceptual Change

S11.3 SC-Paper Set: Development of Concept in the Biological and Physical Sciences
3:00pm – 4:30pm, Grand Ballroom F
Presider: Donna Lewis

S11.3.1 Promoting Middle School Students' Understanding and Integration of Multiple Conceptual Models in Genetics
Hava B. Freidenreich, Rutgers University
Ravit Golan Duncan, Rutgers University

S11.3.2 Linear Estimation: Contexts and Spatial Abilities
Jennifer H. Forrester, NC State University
M. Gail Jones, NC State University
Amy R. Taylor, University of North Carolina
Grant E. Gardner, NC State University

S11.3.3 Students' Conceptions of the Human Cardiovascular System: Levels of Understanding and Implications for Learning
Philipp Schmiemann, University of Duisburg-Essen, Germany
Martin Linsner, University of Duisburg-Essen, Germany
Angela Sandmann, University of Duisburg-Essen, Germany

S11.3.4 A Ten-Year Study Following Students' Ideas about Situations in Which Transformations of Matter Occur
Lena Löfgren, Kristianstad University College, Sweden

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S11.4 SC-Paper Set: Science Achievement and Inquiry Based Learning
3:00pm – 4:30pm, Garden 2
Presider: Gillian Bayne, Lehman College of the City University of New York

S11.4.1 Windows into High-Achieving Science Classrooms
Joseph A. Taylor, BSCS Center for Research and Evaluation
Molly A.M. Stuhlsatz, BSCS Center for Research and Evaluation
Rodger W. Bybee, PISA

S11.4.2 Testing a Premise of Inquiry-Based Science Instruction: Exploring Small Group Processes and Its Link to Student Learning
Maria Araceli Ruiz-Primo, Univeristy of Colorado Denver
Maria Figueroa, Stanford University

S11.4.3 The Influence of Motivation and Epistemological Beliefs on Students' Achievement
Aylin Cam, Middle East Technical University

S11.4.4 Cycles of Exploration, Reflection, and Telling in Model-Based Learning of Genetics
Beaumie Kim, Nanyang Technological University, Singapore
Suneeta A. Pathak, National Institute of Education, Singapore
Michael J. Jacobson, The University of Sydney, Australia
Baohui Zhang, Nanyang Technological University, Singapore
Feng Deng, Nanyang Technological University, Singapore

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S11.5 Related Paper Set: Using Cogenerative Dialogue to Expand the Participation and Achievement of Urban Youth in and Out of School
3:00pm – 4:30pm, Garden 3
Presider: Kenneth G. Tobin, CUNY
Discussant: Rowhea Elmesky, Washington University

S11.5.1 Using Cogenerative Dialogues to Improve High School Science and to Expand the Potential of Youths' Social Lives
Kenneth G. Tobin, CUNY
Reynaldo Llena, CUNY
Rowhea Elmesky, Washington University

S11.5.2 Exploring Multiple Outcomes: Using Cogenerative Dialogues and Coteaching in a Middle School Science Classroom
Nicole K. Grimes, CUNY

S11.5.3 The Role of Face-to-Face Interactions in Developing Scientific Fluency
Ashraf Shady, Queens College, CUNY

S11.5.4 Improving Science Achievement Using Cogenerative Dialogue and Coteaching
Reynaldo Llena, CUNY
Kenneth G. Tobin, CUNY

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies

S11.6 SC-Paper Set: Effects of Curriculum Initiatives in Secondary Schools
3:00pm – 4:30pm, Salon III
Presider: Denise C. Strickland, University of South Carolina

S11.6.1 The Effect of a Laboratory-Based Genetics Program on High School Student Learning: A Comparative Analysis
Victoria L. May, Washington University
Patricia Simmons, University of Missouri

S11.6.2 Promoting Students' Conceptual Understanding on Plants' Responses Using Fighting Plant Learning Module (FPLM)
Nantawan Nantawanit, Mahidol University, Thailand
Pintip Ruenwongsa, Mahidol University, Thailand
Bhinyo Panigpan, Mahidol University, Thailand

S11.6.3 A Study of Three Science Teachers' Implementation of Inquiry-Based Curriculum
Jing Chen, Michigan State University
David Fortus, Weizmann Institute of Science

S11.6.4 Using Video Games in Science Instruction: Pedagogical and Design Challenges
Kamini Jaipal, Brock University
Candace Figg, Brock University

Strand 5: College Science Teaching and Learning (Grades 13-20)

S11.7 Related Paper Set: Studying Conceptual Understanding in Physics
3:00pm – 4:30pm, Salon IV

S11.7.1 Analogical Scaffolding: The Use of Analogy and Representation to Promote and Understand Conceptual Learning in Physics
Noah D. Finkelstein, University of Colorado
Noah S. Podolefsky, University of Colorado

S11.7.2 Using Concrete and Abstract Contexts to Study Conceptual Understanding
Andrew F. Heckler, The Ohio State University

S11.7.3 Evolving Student Knowledge in a Physics Classroom
Eleanor C. Sayre, The Ohio State University
Andrew F. Heckler, The Ohio State University

S11.7.4 The Role of Modeling Instruction in Establishing Supportive Learning Environments for Traditionally Underrepresented Students
Eric Brewe, Florida International University
Laird Kramer, Florida International University
George OBrien, Florida International University
Vashti Sawtelle, Florida International University

Strand 6: Science Learning in Informal Contexts

S11.8 Strand Invited Symposium: News Media Impacts on Public Understanding of Science
3:00pm – 4:30pm, Salon V
Presider: Cathlyn D. Stylinski, University of Maryland
Discussants: Martin Storksdieck, Institute for Learning Innovation
Eliene Augenbraun, ScienCentral, Inc.
John Falk, Oregon State University
John Fraser, Institute for Learning Innovation
Anthony Kola-Olusanya, University of Toronto
Jon Miller, Michigan State University
Patricia Moy, University of Washington
Bachir Raissouni, Alakhawayn University, Morocco

Strand 7: Pre-service Science Teacher Education

S11.9 SC-Paper Set: Preservice Teacher Education and Physics
3:00pm – 4:30pm, Salon II
Presider: Jay Fogleman

S11.9.1 Physics Student Teacher's Professional Knowledge und Professional Action Competence
Josef Riese, University of Paderborn, Germany
Peter Reinhold, University of Paderborn, Germany

S11.9.2 Effects of a Learning Cycle Lesson on Electromagnetic Radiation on the Achievement and Beliefs about Science Teaching Among Elementary Education Pre-Service Teachers
Kevin C. Wise, Southern Illinois University
Frackson Mumba, Southern Illinois University

S11.9.3 Impact on Conceptual Understanding and Attitudes toward Teaching of Pre-service Teachers in an Astronomy Course Designed Using Backwards Faded Scaffolding
Timothy F. Slater, University of Wyoming
Stephanie J. Slater, University of Wyoming

S11.9.4 Fostering Pre-Service Teachers' Development of Pedagogical Content Knowledge in Physics
Mary Kay Kelly, University of Dayton
Todd B. Smith, University of Dayton

Strand 8: In-service Science Teacher Education

S11.10 SC-Paper Set: Identity and Beliefs
3:00pm – 4:30pm, Salon I
Presider: Christine R. Lotter, University of South Carolina

S11.10.1 Connectedness and Trust as a Feature of Effective Mathematics and Science Professional Development
Therese Shanahan, UC Irvine
Silvia Swigert, UC Irvine
Tiffany Lockhart, UC Irvine
Asim Kazi, UC Irvine
Connie Tran, UC Irvine

S11.10.2 Science Teachers' Professional Identity and Beliefs with Relation to Reform Initiatives
Ji Y. Hong, University of Oklahoma
J. Steve Oliver, University of Georgia
Penelope M.D. Vargas, University of Oklahoma

S11.10.3 Secondary Science Teachers' Beliefs of Learning and Knowledge and their Influence on Inquiry-based Practices
Christine R. Lotter, University of South Carolina
Greg Rushton, Kennesaw State University
Jonathan Singer, University of Maryland-Baltimore
Bob Feller, University of South Carolina

S11.10.4 On the Road: Effectiveness of an Experiential Professional Development Program on Teacher Perceptions of Self and Science
Dina Drits, University of Utah
Adam Johnston, Weber State University
Stacy Palen, Weber State University

Strand 8: In-service Science Teacher Education

S11.11 Symposium: Graduate Level Teaching of Nature and Practice of Scientific Inquiry
3:00pm – 4:30pm, Salon VI
Discussant: Barbara Crawford, Cornell University
Presenters: Penny J. Gilmer, Florida State University
Steven Blumsack, Florida State University
Kate Calvin, Florida State University
Brenda Crouch, Panhandle Area Educational Consortium, FL
Douglas Smith, Vernon Middle School, FL
Tiffany Nichols, Carr Elementary and Middle School, FL
Irene Myers, W. R. Tolar K-8 School Bristol, FL
Daphne Hill, Jefferson County High School Monticello, FL
Caren Prichard, Chipley High School Chipley, FL

Strand 9: Reflective Practice

S11.12 Symposium: Reflective Practices and Professional Development through Japanese Lesson Study
3:00pm – 4:30pm, Grand Ballroom G

Michael Kamen, Southwestern University
Meredith Park Rogers, Indiana University
Khemmawadee Pongsnaon, Indiana University
Valarie L. Akerson, Indiana University
James Minogue, North Carolina State University
Sarah J. Carrier, North Carolina State University
Abdulkadir Demir, Georgia State University
Charlene M. Czerniak, The University of Toledo
Nonye M. Alozie, University of Michigan
Ji-Young Kim, University of Illinois at Urbana-Champaign

Strand 10: Curriculum, Evaluation, and Assessment

S11.13 SC-Paper Set: Assessing Science Teacher Knowledge and Skills
3:00pm – 4:30pm, Garden 4

Presider: Debra Tomanek, University of Arizona

S11.13.1 Using Survey of Enacted Curriculum (SEC) Data to Describe Baseline Physical Science Coverage for Illinois Teachers: Results of the Analyses for the Illinois Institute of Technology (IIT) Physical Science Initiative (PSI) Project for Chicago Public Schools

Erica L. Kwiatkowski-Egizio, Illinois Institute of Technology

S11.13.2 Assessing Effectiveness of a Science and Mathematics Teacher Development Program through Use of Virtual Comparison Groups

John F. Cronin, Northwest Evaluation Association
Jeff C. Marshall, Clemson University
Yun Xiang, Northwest Evaluation Association

S11.13.3 Can We Measure Teachers' Pedagogical Content Knowledge (PCK) Using Surveys? Developing Measures of PCK for Teaching High School Biology

Soonhye Park, University of Iowa
Jeongyoon Jang, University of Iowa
Ying-Chih Chen, University of Iowa

S11.13.4 Correlated Science & Math: A New Model for Training Teachers to Link Both Disciplines

Sandra S. West, Texas State University - San Marcos
Lisa A. Gloyna, Texas State University - San Marcos
Mamta Singh, Texas State University - San Marcos
Melissa Duran, Texas State University - San Marcos

Strand 11: Cultural, Social, and Gender Issues

S11.14 SC-Paper Set: Teacher Beliefs and Inclusive Science Teaching
3:00pm – 4:30pm, Salon VII

Presider: Cassie Quigley, Indiana University

S11.14.1 Urban Teachers' Beliefs and Practice of Contextualized Science Teaching

Younkyeong Nam, University of Minnesota
Hui-Hui Wang, University of Minnesota
Bhaskar Upadhyay, University of Minnesota

S11.14.2 Investigating Secondary Science Teacher's Beliefs about Multiculturalism and its Expression in the Classroom

Lori Petty, Texas Tech University
Ratna Narayan, Texas Tech University

S11.14.3 Using an Argumentation-Based Course to Explore Teachers' Cosmological Ideas

Meshach M.B. Ogunniyi, University of the Western Cape, South Africa

S11.14.4 Virtual Environment for Ethical Sensitivity Assessment and Its Impact on Science Educators

Shawn Y. Holmes, North Carolina State University
Leonard A. Annetta, North Carolina State University
Meng-Tzu Cheng, North Carolina State University
Elizabeth Folta, North Carolina State University

Strand 12: Educational Technology

S11.15 SC-Paper Set: Multiple Perspectives on Evaluating Technology-Rich Learning Environments
3:00pm – 4:30pm, Salon VIII

Presider: Hee-Sun Lee, Tufts University

S11.15.1 Edutainment Software Programs in the Genetic Course: Ten Grade Students' Science Process Skills and Attitudes toward Science

Yilmaz Kara, Karadeniz Technical University, Turkey

S11.15.2 The Impact of Implementing Technology-Enabled Active Learning (TEAL) on Student Learning in Taiwan

Ruey S. Shieh, Tatung Institute of Commerce and Technology
Jawluen Tang, National Chung Cheng University

S11.15.3 PowerPoint in the Science Classroom: Reforms-Based Instruction or High-Tech Chalk & Talk?
Christine G Schnittka, University of Virginia
Ian C. Binns, Louisiana State University
Randy L. Bell, University of Virginia

S11.15.4 Factors that Compromise the Potential of Technological Tools in Fostering Authentic Inquiry in Science Classrooms
Noemi Waight, University at Buffalo, SUNY
Fouad Abd-El-Khalick, University of Illinois at Urbana-Chmpaign

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Strand 13: History, Philosophy, and Sociology of Science

S11.16 Symposium: Should Pseudoscience Studies Become an Integral Part of NOS and Scientific Inquiry Curricula?
3:00pm – 4:30pm, Garden 1
Presider: Sherry A. Southerland, Florida State University
Presenters: Julie Gess-Newsome, Northern Arizona University
Norman G. Lederman, Illinois Institute of Technology
Ron Good, Louisiana State University
Mike U. Smith, Mercer University
Lawrence C. Scharmann, Kansas State University

Strand 15: Policy

S11.17 SC-Paper Set: The Long View: How Science Education Policy is Made and Changes over Time
3:00pm – 4:30pm, Grand Ballroom E
Presider: Jane Butler Kahle, Miami University

S11.17.1 Ups and Downs Ranking of Science Education Institutional Research Productivity
Lloyd H. Barrow, University of Missouri
Nai-En Tang, University of Missouri

S11.17.2 A Qualitative Study Examining Ontario Science Curriculum Policy-Making Development and Decision Making Processes from 1985 to 2008
Marietta Bloch, Roehampton University, UK

S11.17.3 Single Gender Education in Science: Policy Issues and Implications for Research
Amber R. Jarrard, University of Georgia
Julie Kittleson, University of Georgia

Concurrent Session #12
4:45pm – 6:15pm

International Committee Sponsored Session

S12.1 Symposium: Approaches to Teaching and Learning Science that Foster Interest and Understanding: Examples from Australia and New Zeland
4:45pm – 6:15pm, Grand Ballroom D
Presider: Mei-Hung Chiu, National Taiwan Normal University
Presenters: David F. Treagust, Curtin University, Australia
Christine Howitt, Curtin University, Australia
Elaine Blake, Curtin University, Australia
Gillian Kidman, Queensland University of Technology
Garry Hoban, University of Wollongong, Australia
Philemon Chigeza, James Cook University, Australia
Kimberley Wilson, James Cook University, Australia
Kathy Brazier, University of Waikato
Deborah Corrigan, Monash University

Research Committee Sponsored Session

S12.2 Technology Symposium: Grand Challenges in Technology Enhanced Learning in Science
4:45pm – 6:15pm, Pacific Room
Marcia Linn, University of California, Berkeley
Robert Tinker, The Concord Consortium
Douglas Clark, Arizona State University

Strand 1: Science Learning, Understanding and Conceptual Change
S12.3 SC-Paper Set: Textbooks, Reading and Writing Science
4:45pm – 6:15pm, Grand Ballroom F
Presider: Linda Keen-Rocha, University of South Florida

S12.3.1 A Study of Statements of Lexicon Relations and Students' Understanding Ii Science Textbooks
Shih Wen Chen, Chung Zhen Primary School, Taiwan
Wen Gin Yang, National Taiwan Normal University, Taiwan
Min Shiung Chuang, National Kaohsiung Normal University, Taiwan

S12.3.2 A Secondary Reanalysis of Student Perceptions while Participating in Non-traditional Writing in Science
Mark A. McDermott, University of Iowa
Brian Hand, University of Iowa

S12.3.3 Discernment of Referents - An Essential Aspect of Conceptual Change
Helge R. Stroemdahl, Linköping University, Sweden

S12.3.4 Understanding Secondary Students' Acquisition of Scientific Literacy
Paul J. Preczewski, Syracuse University
Alexandra Mittler, Syracuse University
John W. Tillotson, Syracuse University

S12.3.5 In What Ways do Students Attend to Prose and Graphics When reading Science Texts?
Mary H. van de Kerkhof, University of Michigan

Strand 1: Science Learning, Understanding and Conceptual Change

S12.4 Symposium: Supporting Student and Teacher Learning about Modeling Practices
4:45pm – 6:15pm, Grand Ballroom G
Presider: Brian J. Reiser, Northwestern University
Presenters: Andres Acher, Northwestern University
Hamin Baek, Michigan State University
Jing Chen, Michigan State University
Michelle Cotterman, Wright State University
Elizabeth A. Davis, University of Michigan
David Fortus, Weizmann Institute of Science
David Grueber, Wayne State University
Hayat Hokayem, Michigan State University
Barbara Hug, University of Illinois at Urbana-Champaign
Lisa Kenyon, Wright State University
Joe Krajcik, University of Michigan
Michele Nelson, University of Michigan
Gerald Rau, University of Michigan
Christina Schwarz, Michigan State University
Yael Shwartz, Weizmann Institute of Science
Tang Wee Teo, University of Illinois at Urbana-Champaign
Jodie Wilson, Wright State University

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S12.5 SC-Paper Set: Exploring Teacher Practices and Student Perception in Science Education
4:45pm – 6:15pm, Garden 2
Presider: Christopher Harris, University of Arizona

S12.5.1 "Are You Curious As To Whether Crayfish Have A Sweet Tooth Or Not?" Teacher Questioning In Inquiry-Based Science Classrooms
Alandeom W. Oliveira, University at Albany, SUNY

S12.5.2 Chinese Students' Interest of Science Learning: Preliminary Findings from the ROSE Study in Three Cities of China
May Hung Cheng, The Hong Kong Institute of Education
Yau Yuen Yeung, The Hong Kong Institute of Education

S12.5.3 Exploring the Relationship between Teacher Content Knowledge and Student Learning
Sean Smith, Horizon Research, Inc.

S12.5.4 American Muslim Students Perceptions of Science and Science Learning: An Exploratory Study from a Private Islamic School
Sara L. Salloum, Long Island University - Brooklyn Campus
Saouma BouJaoude, American University of Beirut

Strand 2: Science Learning: Contexts, Characteristics and Interactions

S12.6 Related Paper Set: Understanding Identities and Disposition
4:45pm – 6:15pm, Garden 3
Presider: Wesley Pitts, Lehman College of the City University of New York

S12.6.1 Learning To Teach as Identity Re/Production
Jennifer Adams, Brooklyn College of the City University of New York

S12.6.2 Science, Cogenerative Dialogues and Maria: Providing a Venue to Improve the Science Experiences of Physically Disabled Children
Gillian U. Bayne, Lehman College of the City University of New York

S12.6.3 Where's the Beef? In Search of Science Content Knowledge in Cogenerative Dialogues
Femi Otulaja, City University of New York

S12.6.4 From Rap to Chemistry: Using Culturally Adaptive Practices to Teach and Learn Chemistry
Wesley Pitts, Lehman Colleger of the City University of New York
Nader Markarious, University of Pennsylvania

Strand 4: Science Teaching--Middle and High School (Grades 5-12): Characteristics and Strategies

S12.7 Related Paper Set: Development of Teacher Beliefs and their Instructional Practice
4:45pm – 6:15pm, Salon III
Presider: Reinders H. Duit, Leibniz Institute for Science Education, Kiel, Germany
Discussant: Barbara Crawford, Cornell University

S12.7.1 Dutch and German Chemistry Teachers' Beliefs about the Curriculum and about Teaching and Learning
Jan Van Driel, University of Leiden, The Netherlands

S12.7.2 Beliefs and Practices of Beginning Secondary Science Teachers: The First Two Years in the Classroom
Sissy Wong, Arizona State University, Tempe
EunJin Bang, Iowa State University
Julie A. Luft, Arizona State University
Krista Adams, Arizona State University
Jonah Firestone, Arizona State University
Jennifer Neakrase, Arizona State University
Ira Ortega, Arizona State University

S12.7.3 Biology Teachers' Attitudes and Beliefs towards Competence-Oriented Teaching and Their Instruction Practice
Markus Lücken, Leibniz Institute for Science Education, Kiel, Germany

S12.7.4 Development of Physics Teachers' Beliefs about Good Instruction and Their Instructional Behaviour
Silke Mikelskis-Seifert, Leibniz Institute for Science Education, Kiel, Germany
Reinders H. Duit, Leibniz Institute for Science Education, Kiel, Germany

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Strand 5: College Science Teaching and Learning (Grades 13-20)

S12.8 SC-Paper Set: Innovations in Instruction
4:45pm – 6:15pm, Salon IV
Presider: Kate Popejoy, University of North Carolina, Charlotte

S12.8.1 Exploring Changes in University Instructor Thinking: Influence on Contextual Factors within a Departmental Teaching Culture
Erika G. Offerdahl, North Dakota State University

S12.8.2 Scientific Reasoning and Epistemological Commitments: Coordination of Theory and Evidence among College Science Students
Ava A. Zeineddin, Wayne State University
Fouad Abd-El-Khalick, University of Illinois

S12.8.3 How Does Collaborative Teamwork Support Student Achievement and Self-Efficacy?
Senay Purzer, Purdue University
Dale R. Baker, Arizona State University
Sibel Uysal, Arizona State University

S12.8.4 Transformation of a Large Lecture Course Using an Inquiry-Based Course for Preservice Teachers as a Model: Clear as a Bell or Lost In Translation?
Emily J. Borda, Western Washington University
Johanna Brown, Western Washington University
Alison K. Dickinson, Longview School District
Lindsey Anderson, Western Washington University
Kory Abercrombie, Western Washington University
Rose Ekins, Western Washington University

Strand 7: Pre-service Science Teacher Education

S12.9 SC-Paper Set: Reflection and Co-Teaching in Preservice Teacher Education
4:45pm – 6:15pm, Salon II
Presider: Deborah Smith, Penn State

S12.9.1 Ten Years of Coteaching in Science Teacher Education: Addressing the Criticisms
Karen Carlisle, Queens University Belfast
Colette Murphy, Queens University Belfast
Jim Beggs, St Marys University College

S12.9.2 Reflecting on Practice: Using Coplanning for Teacher Development
Kathryn Scantlebury, University of Delaware
Jennifer Gallo-Fox, University of Delaware
Beth Wassell, Rowan University

S12.9.3 Inter-Relations Between and Among Reflection, Use of a Teacher Perspective, Musings/Wonderings, and Explicitly Stated Principles of Practice in the Work of Preservice Teachers
Deborah J. Trumbull, Cornell University
Kimberly N. Fluet, Illinois Institute of Technology
Alfa Choice, Cornell University

S12.9.4 Assessing the Efficacy of Co-Taught Elementary Science Methods Courses
Peter M. Meyerson, UWO
Stephen Rose, UWO
John Lemberger, UWO
Mike Beeth, UWO

Strand 7: Pre-service Science Teacher Education

S12.10 SC-Paper Set: The Role of Content for Preservice Teachers
4:45pm – 6:15pm, Salon V
Presider: Gail Richmond, Michigan State University

S12.10.1 How Do We Prepare Student Teachers to Teach Science for Sustainable Development?
Astrid T. Sinnes, Norwegian University of Life Sciences
Birgitte Bjønness, NorwegianUniversity of Life Sciences

Earth Science Faculty's Collaborative Pedagogical Practice and Professional Image in an Introductory Earth Science Teacher Education Course
Yueh-Hsia Chang, National Taiwan Normal University
Chun-Yen Chang, National Taiwan Normal University

S12.10.2 Sound and Sensibility: Science Teacher Students Bridging Phenomena and Concepts
Edvin Ostergaard, University of Life Sciences, Norway
Bo Dahlin, Karlstad University, Sweden

S12.10.3 Developing Disciplinary Practices to Support the Pedagogical Practices of Prospective Elementary Teachers
Amy B. Palmeri, Vanderbilt University

S12.10.4 Challenges of Connecting Science Learners with Science Content for Secondary Science Teacher Candidates
Hosun Kang, Michigan State University
Charles W. Anderson, Michigan State University

Strand 8: In-service Science Teacher Education

S12.11 SC-Paper Set: Classroom Impact
4:45pm – 6:15pm, Salon I
Presider: Jonathan E Singer, University of Maryland

S12.11.1 Professional Development for Elementary Teachers of Science in Thailand: A Holistic Examination
Kusalin Musikul, Institute for the Promotion of Teaching Science and Technology, Thailand
Sandra K. Abell, University of Missouri-Columbia

S12.11.2 Characteristics of Professional Development and Impact of Training on Science Teachers' Classroom Practices
Tunde Owolabi, Lagos State University, Nigeria
Peter A. Okebukola, Lagos State University, Nigeria

S12.11.3 Threaded Professional Development: A Study of Classroom Impact
Jonathan E. Singer, University of Maryland
Christine Lotter, University of South Carolina
Robert Feller, University of South Carolina
Al Gates, School District Five of Lexington and Richland Counties

S12.11.4 The Role of Transformative Professional Development Based on Educative Materials in Affecting Teacher PCK, Classroom Practice, and Student Achievement
Julie Gess-Newsome, Northern Arizona University
Janet Carlson, BSCS
Christopher D. Wilson, BSCS

Strand 10: Curriculum, Evaluation, and Assessment

S12.12 SC-Paper Set: Teaching and Assessing Nature of Science
4:45pm – 6:15pm, Garden 1
Presider: Rachel Mamlok-Naaman, Weizmann Institute of Science

S12.12.1 How Do the High School Biology Textbooks Introduce the Nature of Science?
Young H. Lee, University of Houston
Eugene L. Chiappetta, University of Houston

S12.12.2 Increase of Inquiry Competence: A Longitudinal Large-Scale Assessment of Students' Performance from Grade 5 to 10
Andrea Moeller, Justus-Liebig-University Giessen, Germany
Christiane Grube, Justus-Liebig-University Giessen, Germany
Stefan Hartmann, Justus-Liebig-University Giessen, Germany
Juergen Mayer, Justus-Liebig-University Giessen, Germany

S12.12.3 Representations of the Processes and Nature of Science: Scientific Inquiry in an Agricultural Science Classroom
Julie R. Grady, Arkansas State University
Erin L. Dolan, Virginia Polytechnic Institute & State University
George Glasson, Virginia Polytechnic Institute & State University

S12.12.4 Characteristics of Science Questionnaire (CSQ): Assessing the Nature of Science
Bradford N. Talbert, Pleasant Grove High School
Christian K. Davies, Brockbank Junior High School
David Kent, Independence High School
Adam Mitchell, Diamond Fork Junior High School
Nikki L. Hanegan, Brigham Young University

Strand 10: Curriculum, Evaluation, and Assessment
S12.13 SC-Paper Set: Evaluating the Impact of Curriculum Innovations
4:45pm – 6:15pm, Garden 4
Presider: Xiufeng Liu, State University of New York at Buffalo

S12.13.1 The Nature of Science and Physics First: Does Course Sequence Influence Students' Perceptions of the Nature of Science?
James V. Neufell, Jr., Rutgers University

S12.13.2 Investigating the Impact of Coordinated Reform-Based Physics and Chemistry Curricula on Student Learning: A Quasi-Experiment
Ling L. Liang, La Salle University
Gavin Fulmer, Westat
Richard Clevenstine, Ridley School District
Raymond Howanski, Ridley School District

S12.13.3 Multi-Level Assessment of Scientific Content Knowledge Gains Associated with Socioscientific Issues-based Instruction
Michelle L. Klosterman, University of Florida
Troy D. Sadler, University of Florida

S12.13.4 Evaluating the Impact of Science Fair Participation on Student Understanding of the Scientific Process Using a Collaborative Evaluation Communities Approach
Dana Atwood-Blaine, University of Kansas
Doug Huffman, University of Kansas
Bria Klotz, University of Kansas

Strand 11: Cultural, Social, and Gender Issues

S12.14 SC-Paper Set: Images across Multiple Contexts
4:45pm – 6:15pm, Salon VII
Presider: Bina Vanmali

S12.14.1 Cultural Models of "Science Person" In Two Fourth-Grade Reform-Based Science Classrooms: Assessing Equity beyond Knowledge- and Skills-Based Outcomes
Heidi B. Carlone, The University of North Carolina
Julie Haun-Frank, The University of North Carolina
Angela W. Webb, The University of North Carolina
Mark Enfield, Elon University
Stacey M. Reavis, The University of North Carolina

S12.14.2 Students' Embodied Images of Science and Scientists: Sculpted by Culture? An International Study
Ratna Narayan, Texas Tech University
Soonhye Park, University of Iowa
Deniz Peker, Middle Eastern University
Bapin Ding, Capital Normal University
Jeong-Yoon Jang, University of Iowa

S12.14.3 Students' Presuppositions of What the World is Like and Their Interest in Choosing Science
Britt Lindahl, Kristianstad University Sweden
Lena Hansson, Kristianstad University Sweden

S12.14.4 Learning without Interest: Science Learning in Korea
Nam-Hwa Kang, Oregon State University
Miyoung Hong, Korea Institute for Curriculum and Evaluation

Strand 11: Cultural, Social, and Gender Issues

S12.15 Related Paper Set: Culturally Responsive Science Teaching and Learning in a Multicultural Elementary School: A Researcher-Practitioner Design Collaboration

4:45pm – 6:15pm, Salon VIII

Presider: Suzanne Reeve, University of Washington

S12.15.1 Valuing Prior Understandings: Young People's Ideas about Health and Nutrition in a Multicultural Community

Suzanne Reeve, University of Washington

S12.15.2 Micros and Me: Connecting Repertoires of Practice between Home and School

Carrie Tzou, University of Washington
Philip Bell, University of Washington

S12.15.3 The Scientific Practice of Observation across Social Settings:

Heather Zimmerman, Pennsylvania State University

S12.15.4 Design Collaborations as Professional Development: Orienting Teachers to Their Students' Everyday Expertise

Philip Bell, University of Washington
Carrie Tzou, University of Washington
Patricia Koeller, Seattle School District
Elyse Litvack, Seattle School District
Marcia Ventura, Seattle School District

Strand 14: Environmental Education

S12.16 Strand Invited Symposium: Eco-Justice in and through Science Education: A Community Discussion

4:45pm – 6:15pm, Salon VI

Discussant: Teddie Mower, University of Louisville

Presenters: Steve Alsop, York University
Larry Bencze, University of Toronto
Michael P. Mueller, University of Georgia – Athens
Deborah Tippins, University of Georgia – Athens

Strand 15: Policy

S12.17 SC-Paper Set: Policy in Action: Transition from High School to College

4:45pm – 6:15pm, Grand Ballroom E

Presider: Sarah Carrier, North Carolina State University

S12.17.1 Student Persistence in Science and Mathematics from High School through College

Adam V. Maltese, Indiana University

S12.17.2 The Development and Validation of the Teachers Goals for Science Education Scale: Moving Toward Understanding Teachers Interpretation of Policy

Todd L. Hutner, Lyndon B. Johnson High School Austin, TX
Sherry A. Southerland, The Florida State University
Victor Sampson, The Florida State University

Evening/Social Events

Special Social

This special social event is open to all NARST members. Join us in an evening of fun and relaxation while we listen to the Elm Street Band play with their "California Attitude" style. Free appetizers and a cash bar will be available.

6:30pm – 9:30pm, Royal Ballroom

FARSE-Social

This comedy event is open to all NARST members.

8:00pm – 10:00pm, Pool - North Tower

Tuesday, April 21, 2009

NARST Executive Board Meeting Session #3
7:30am – 11:30am, Valencia

All NARST Board Members must be in attendance. Newly elected Board Members are required to attend.

Abstracts

S0.1 Pre Conference Workshop—Equity and Ethics Committee Sponsored
Grand Challenges and Great Opportunities in Science Education for Scholars of Color

Maria Rivera, Barnard College
Felicia Moore Mensah, Columbia University
Eileen C Parsons, University of North Carolina
Jerome Shaw, University of California-Santa Cruz
Claudette Giscombe, University of Massachusetts-Amherst
Sumi Hagiwara, Montclair State University
Malcolm Butler, University of South Florida

The pre-conference workshop will emphasize opportunities available to scholars of color outside in science education. Each panelist may offer some specific advice about how to conduct research and take advantage of their unique positions as scholars of color. The panel will field questions from the audience relevant to the grand challenges and great opportunities as scholars of color in science education. Attendees will work in small groups to outline personal or individual plans of research that they may continue to develop after the NARST conference.

S0.2 Pre Conference Workshop—Research Committee Sponsored
From Teaching to "Know" – to Learning to "Think"; Science Education for Sustainability

Uri Zoller, University of Haifa, Israel

Given the current world state of affairs, the striving for sustainability and the consequent paradigms shift, such as from correction-to-prevention and from options selections-to-options generation, the corresponding paradigms shift in science education, such as from the dominant traditional lower-order cognitive skills (LOCS) algorithmic teaching to higher-order cognitive skills (HOCS)-promoting learning, is unavoidable. Indeed, the latter shift is in the core of the current reforms in science education, worldwide. It requires new types of flexible, contextually-bound relevant, adaptive knowledge and, more so, persistent, purposed development of students' evaluative, critical and system thinking, decision making and problem solving for effectively and responsibly dealing/coping with the complexity and fragility of multi-dimensional socio-economical-technological-environmental systems. The guiding rationale of this workshop is based on the identification and conceptualization of the paradigms shift contemporarily occurring in people's/societies' world outlook, policies, economic, scientific and technological research and, consequently, in education, science education in particular. This workshop will focus on 'HOW TO DO IT'; namely, how to 'translate' the tandem active research and science teaching methodology into practice in different contexts, via exemplary science, technology, environment, society (STES)-oriented science teaching. Exemplary modules, teaching strategies, HOCS/evaluative thinking – promoting assessment methodology, applicable at all levels of education, will be presented followed by selected examples – to be generated, worked out and formatted, collectively in groups, by the workshop participants, based on their particular contexts, age group and level (of their students), and needs as well as related supporting examples of formative evaluation-type research to be presented and discussed. All of the above is targeted at contributing to science education via in vivo persistent development of students' HOCS and transfer capabilities.

S0.3 Pre Conference Workshop—Research Committee Sponsored
How Can We Plug the Hole in the Bucket? Addressing Beginning Science Teacher Retention Issues Before It's Too Late

Donna R. Sterling, George Mason University
Wendy M. Frazier, George Mason University
Jason Calhoun, Prince William County Schools
Myra Thayer, Fairfax County Public Schools

Each academic year, science teacher retention is becoming a more critical issue that we need to face before it's too late. Small numbers of fully prepared teachers are entering the teaching profession in many regions. Therefore, as the retirement rate is growing or teachers leave in frustration, school systems are hiring under-prepared teachers and these teachers are not staying. Some fail at the job and leave under their own will or sometimes forcibly. Others show promise and do a reasonable job, but are so overwhelmed by the job and lack of support that they opt to leave the profession even though the school districts would like to continue their employment. This workshop provides a forum in which fellow science educators can share what is working to help new science teachers to succeed at teaching and remain in the profession. Workshop attendees will discuss this growing problem and critically reflect upon strategies designed to target new science teachers' skills in classroom management, instruction, and assessment in addition to general teacher survival strategies. Issues specific to the retention of science teachers versus teachers of other content areas will be explored and networking opportunities will be encouraged. Material developed and presented in this workshop has been based upon work supported by the National Science Foundation under Grant No. 0302050 (2003-2009).

PL.1 Plenary Session—Teaching and Learning for the 21st Century

Linda Darling Hammond, Stanford University, Charles E. Ducommon Professor of Education

Identified in 2006 as one of the nation's ten most influential people affecting educational policy over the last decade, Dr. Darling Hammond has focused her research on teaching, and policy work focus on issues of school restructuring, teacher quality and educational equity. Additionally, Dr. Darling Hammond was educational advisor to Barack Obama's presidential campaign.

S1.1 Presidential Invited Session—Between Sputnik's Launch and Halley's Return: Grand Challenges at the Crossroads

John Settlage, University of Connecticut
Adam Johnston, Weber State University

Science education stands at a crossroads. What Sputnik put into motion in 1957 is expected to be resolved by the year 2061. Approaching the halfway point offers us a time to pause and reflect. How have we responded to the grand challenges? What great opportunities have we yet to embrace? How are the answers to such questions relevant at the individual, institutional and organizational levels? Join us in a rousing consideration of the predicaments … and the possibilities.

S1.2 Equity and Ethics Committee Sponsored Session—Opportunities and Challenges of Equitable Science: A Call for Action at Many Levels

Jrene Rahm, University of Montreal
Valarie L. Akerson, Indiana University
Dorish Ash, University of California, Santa Cruz
Mary Atwater, University of Georgia
Mary Bang, TERC & American Indian Center of Chicago
Cory A. Buxton, University of Georgia
Angela Calabrese Barton, Michigan State University

Equitable science is about accessibility, empowerment, and agency. All children, youth and teachers should have opportunities to engage in a science that is meaningful to them and psychologically and culturally accessible irrespective of who they are (Delgado, 2002). All children, youth and teachers should experience opportunities to put science to work in ways that is empowering for them and their communities, in ways that may improve their lives and may make engagement with science a pleasurable and worthwhile activity for all involved. Children, youth, and teachers should have opportunities to experience agency as they put science to work and become change agents of science and its politics in their communities (Dhingra & Hagiwara, 2006). They should all have access to a science that they can then use reflexively to critique and deconstruct science and the world they live in (Roth & Calabrese Barton, 2004). Equitable science is also about responding to the effects of globalization that have left us with extensive racial/ethnic, cultural, linguistic, and socioeconomic diversity which calls for the valuing of, and respect of nonmainstream students' funds of knowledge, histories, and communities (Lee & Kuykx, 2006). Yet, are such issues currently really addressed by the brokers of science and if so, how are they put into action? The invited panel will respond to these questions, speaking on behalf of the following research areas in science education: 1) science teachers; 2) science teacher educators; 3) museums and vast infrastructure of informal science; 4) tools of science such as the curriculum or the technology, and 5) policy makers. In each case, they will address the ways their field has responded to the challenges yet also unique opportunities issues of diversity, accessibility, empowerment and agency in science education pose. The common themes and challenges across the five areas will be highlighted as they are raised and in turn picked up by a discussant who will assess them critically in ways that will open up the session to further uptake and discussion by the audience.

S1.3 Strand 1—Poster Symposium: Learning Progressions for Principled Accounts of Processes in Socio-Ecological Systems

Charles W. Anderson, Michigan State University
Richard A. Duschl, Pennsylvania State University
Joseph Krajcik, University of Michigan
Lindsey Mohan, Michigan State University
Hui Jin, Michigan State University
Jing Chen, Michigan State University
Edna Tan, Michigan State University
Kristin L. Gunckel, University of Arizona
Beth A. Covitt, Michigan State University
Josephine Zesaguli, Michigan State University
Blakely K. Tsurusaki, Washington State University, Pullman

In this interactive poster symposium we describe and discuss the development of learning progressions from upper elementary grades through college focusing on preparing students to become environmentally informed citizens. The session is reports progress since a poster symposium presented at NARST last year. Posters describe students' learning progressions in four areas: carbon cycling, water cycling, biodiversity, and citizenship practices. The posters describe significant advances in five areas: 1. Understanding of learners' reasoning. We present a more robust framework to describe the development of learners' reasoning, focusing on the transition from force-dynamic to principled reasoning. 2. Progress in empirical validation of learning progressions. We report on larger data sets collected with improved written instruments and clinical interviews, and on quantitative analyses that validated our frameworks and assessment instruments. 3. Additional international data. Two posters compare the reasoning of American and Chinese middle school and high school students about carbon cycling. 4. Analyses of effects of instruction. One poster compares middle school and high school students' written assessments before and after instruction about carbon cycling processes. 5. Extended grade range: upper elementary to college. One poster analyzes college science majors' performance on written assessments of carbon cycling processes.

S1.4 Strand 1—Symposium: Model-Based Learning in Experts and in the Classroom

This symposium is focused on how students learn to use dynamic mental models and what teachers can do in the classroom if they adopt a view of learning as involving the creation and use of dynamic mental models. The theoretical framework shared by the presenters is exemplified in work reported in a study with experts. The theory describes how scientists and students construct mental models using reasoning processes such as the use of extreme cases and model construction cycles. Three other studies apply aspects of this theory at the classroom level, investigating the role of model-construction processes in student learning and how some teachers have scaffolded these processes. Teachers were able to facilitate effective elaborations and modifications of initial student model construction attempts while using unique model-based teaching strategies. As a group, these studies argue that looking at teaching and learning with the idea that the learner can iteratively construct and then profitably employ dynamic mental models suggests new strategies to both teachers and learners. Individual Papers and Presenters are as Follows:

S1.4.1 Examining Processes and Outcomes of Applying Model Based Teaching and Learning Processes in ST1- Teaching Practices at the Primary School Level

Maria C. Nunez-Oviedo, University of Concepcion, Chile
Carla Barria, University of Concepcion, Chile
Gonzalo Saez, University of Concepcion, Chile
Sergio Rojas, University of Concepcion, Chile
Jonathan Vargas, University of Concepcion, Chile
Loreto Venegas, University of Concepcion, Chile

S1.4.2 Model Co-Construction in High School Physics: A Case Study of Teachers' Intended Instructional Pathways and Recovery Routes

E. Grant Williams, University of Massachusetts – Amherst

S1.4.3 Extreme Case Reasoning and Model Based Learning in Experts and Students

A. Lynn Stephens, University of Massachusetts - Amherst

S1.4.4 Model Construction in Scientists

John J. Clement, University of Massachusetts – Amherst

S1.5 Strand 2—Related Paper Set: Examining Intervention Efforts to Establish Equitable Science Learning Environments

S1.5.1 From Remediation to Shared Spaces: Implications for Teachers of Historically Low Achieving Science Students

Randy K. Yerrick, SUNY-UB
Anna Luizzo, SUNY-UB
Kenneth Tobin, CUNY

Lower track science classrooms have attracted a variety of prescriptive measures from assessment-driven content delivery teaching strategies to remediation programs for teaching basic facts. Given the student population of lower track classrooms are typically marginalized from the school culture in ways that transcend issues of content delivery or retention, it is not surprising that attempts to employ iterations of transmissional pedagogy fail. If teachers are to be successful re-engaging science students with histories of failure certain shared social, emotional, and cultural connections must be established as mutual attributes of the science learning context. This study employed a Bakhtinian framework to explore how teachers of lower track students may participate in the co-construction of scientific knowledge in ways which mutually enrich science spaces for both parties. It discusses ways that teachers' and students' notion evolved a changing entities as teachers sought to engage students in dialogue to support and assimilate other's words into meaning-making. Implications are discussed for the enrichment of both teacher and students' views of science, school and the world were changed.

S1.5.2 "Who Are You Callin' Expert?": Using Student Narratives to Redefine Expertise and Advocacy Lower Track Science

Jennifer Schiller, SUNY-UB
Randy K. Yerrick, SUNY-UB

The purpose of this study was to examine and interpret dialogue from lower-track science students regarding how and why they chose to learn science from their teachers based on affective attributes, advocacy/impedance, and identity. Data was collected and transcribed from focus groups, teacher journals, classrooms events, and student artifacts. Results showed that lower track science students closely associate affective teacher attributes with effective teaching strategies. In addition, students identified advocacy or impedance in academic success based on personal experience rather than other more overt characteristics (e.g.; race gender) as a major determinant for their successful science learning. Implications for research and teacher education in diverse settings are discussed.

S1.5.3 Developing a Framework for Science Teacher Knowledge by Examining Miscues in Diverse Settings

Joseph Johnson, SUNY-UB
Randy K. Yerrick, SUNY-UB
Jennifer Schiller, SUNY-UB
Zaynab Alnakeeb, SUNY-UB
Dara Dorsey, SUNY-UB

This study draws attention to the complexity of making changes in classroom communities in which students are challenged to adopt fundamentally different ways of thinking, speaking, and acting. Extracted from a series videotaped lessons conducted in a teacher education intervention, this study explicates misguided attempts to revise science instruction for diverse learners. Examined from both student and teacher perspectives, classroom events revealed: 1) Novice teacher's repeated mistakes resulted from misinterpreting science histories, 2) Successful iterations resulted from a wide variety of teaching strategies, not the implementation of a select predetermined few, and 3) Teachers' reflective practices in conjunction with student focus groups contributed to the successful approximations by students and teachers to participate in new discourse practices. Researchers describe how differences between students' and teacher's cultural, historical, and academic perspectives in an intervention study, made it difficult for both will soon arrive with a shared understanding of scientific discourse. Discussed are the implications of the observed changes and lack of change in terms of advocates and barriers for scientific classroom discourse and areas for future research in intervention studies for teacher educators.

S1.5.4 Initiating Technological and Pedagogical Shifts in Low Achieving Urban Minority Classrooms

Brian Meyer, SUNY-UB
Randy K. Yerrick, SUNY-UB
Suzanne Miller, SUNY-UB
Mary Thompson, SUNY-UB

This study explored the introduction of multi-modal teaching strategies alongside technology implementation in high poverty schools. Teachers were provided with scientific tools, simulations, and teaching stations and provided with training and opportunities to practice teaching strategies developed in conjunction with special education and literacy experts. Teacher interviews, classroom observations, and student focus groups comprised the bulk of the sited data supplementing the student achievement scores and pre and post content tests administered for each unit. Findings suggested not all teachers incorporated multi-modal strategies into lessons incorporating technology and that lower achieving students interpreted lessons quite differently than their teachers in these contexts. Implications for ways technology implementations may explicate emerging literacies are discussed.

S1.6 Strand 2—SC-Paper Set: Exploring the Nature of Science and Knowledge Construction in Science Education

S1.6.1 High School Students' Beliefs about Nature of Knowledge and Nature of Knowing: Impact of Constructivist Philosophy

Feral Ogan-Bekiroglu, Marmara University
Gulsen Sengul, Marmara University

Although the importance of epistemological development has been emphasized, there is limited number of research related to what fosters epistemological development and how epistemological views can be changed, especially in pre-college time. Therefore, this study aimed at examining the effects of constructivist instructional practices on high school students' epistemological beliefs. One-group pretest-posttest research design was utilized for the study. Treatment was the instruction based on constructivist philosophy. Hofer and Pintrich (1997)'s model for epistemological beliefs was used with combination of levels determined by Kuhn, Cheney and Weinstock (2000). Before the instruction, all students had held either realist beliefs or absolutist beliefs. Teaching methods and strategies based on constructivist philosophy helped the students move their epistemological beliefs through upper levels.

S1.6.2 A Call for Being Explicit About Science: Inquiry Combined With Instruction in NOS as a Multicultural Education Approach

Xenia Meyer, Cornell University
Barbara Crawford, Cornell University

Due to the growing number of students from populations underrepresented in the sciences there is an intensified need to consider alternatives to traditional science instruction. Inquiry- based instructional approaches provide promise and possibility for engaging underrepresented students in the activities of science. However, inquiry-based instruction by itself, without culturally relevant pedagogy and instructional congruency, may not be enough to support non-mainstream students in science learning, and may even serve to challenge students' cultural ways of knowing. This conceptual paper suggests that aligning reform efforts in science education to the field of multicultural education would buttress efforts to reach underrepresented student groups in science. This includes providing culturally relevant instruction and instruction toward making the assumptions of science explicit, in particular. To this end, this paper draws from literature in multicultural education to propose that deconstructing science through instruction in NOS may support Latino, black and ELL students in science learning.

S1.6.3 What is Technology? A Theoretical Framework for Investigating Student Conceptions about the Nature of Technology

Nicole DiGironimo, University of Delaware

Although the science education community has made it clear, through the standards and scientific literacy literature, that knowledge of the Nature of Technology should be an educational goal, there is a lack of research on student conceptions about the Nature of Technology. The purpose of this research was to consolidate the literature on scientific literacy, technological literacy, and theories of learning

and develop a theoretical framework for investigating student conceptions about the Nature of Technology. The review of the literature led to the identification of three domains of knowledge that completely characterize the Nature of Technology. The theoretical framework for investigating student conceptions about the Nature of Technology was then used to analyze data collected from an exploratory survey distributed to a small group of middle school students. Student responses were coded into themes that represent naïve conceptions about the Nature of Technology. The results suggest that the students sampled do not have a comprehensive understanding of the Nature of Technology.

S1.6.4 Exploring Secondary Students' Views of the Nature of Science and Writing in Science

Isha DeCoito, York University

Writing in science can be used to address some of the issues relevant to contemporary scientific literacy, such as the nature of science. This has implications for the kinds of writing tasks students should attempt in the classroom, and for how students should understand the rationale and claims of these tasks. This mixed-methods study explored secondary science classrooms with a focus on teacher-developed activities, involving diversified writing styles linked to the science curriculum. This study reports on students' views of the nature of science and writing in science. Students' views are illustrated through pre-and post- questionnaire responses; interviews; student work; and classroom observations. Results indicated that there was significant change in students' views of the nature of science over the course of the study and these are directly linked to writing activities in science. Diversified writing activities have the potential to accurately portray science to students, personalize learning in science, improve students' overall attitude towards science, and enhance scientific literacy through learning science, learning about science, and doing science. Finally, the relationship between students' views of the nature of science and writing in science is complex and is dependent on several factors including the teachers' influence and attitude towards student writing in science.

S1.7 Strand 3—SC-Paper Set: Technologies to Promote Science Understanding and Inquiry

S1.7.1 Integrating Scientific Concepts of Motion and Mathematics Concepts of Graphing Using a Motion Detector in a Second and Third Grade Mixed Age Classroom

Jason Kahn, Tufts University
Ronald K. Thornton, Tufts University

This research describes a set of activities that take an integrated approach to science and mathematics education in elementary school. Researchers have noted that motion detectors can be powerful tools for learning about graphs as representational tools and concepts of motion, two traditionally 'difficult' topics, but up to this point little work has been done in the elementary classroom. Seventeen students in a second and third grade mixed age classroom explore concepts of motion and graphing mediated by a motion detector and real-time graphing software. These children engage with the materials on two consecutive days, with each session lasting one hour. Quantitative and qualitative analyses show that children, even in early elementary school and with little instruction, are capable of using graphs as a way to build abstractions about physical motion. These results demonstrate that young children are capable of engaging sophisticated concepts of motion when given an appropriate representational tool, a graph, and the means to interpret such a tool.

S1.7.2 Science Notebooks as a Predictor of Achievement in Reading, Writing, Math, and Science, and of Higher-level Thinking in Science Classrooms

Stephen R. Getty, BSCS Center for Curriculum Development
Joseph A. Taylor, BSCS Center for Research and Evaluation
Linda B. Mooney, Educational Consultant
Paul J. Kuerbis, Colorado College

Science notebooks (SNBs) can be an important instructional tool to help students record, represent, reflect upon, and reinforce their understandings of science, yet it can be difficult to measure the impact of SNBs on student achievement. This research studied SNB use with grades 4 and 5 science kits in 2 districts. An allied professional development (PD) intervention focused on instructional practices, science content, and SNB implementation in science. We have developed and validated a SNB instrument to measure student use of SNBs, and scored about 300 SNBs. In both districts, SNBs scores correlate most highly with writing, and least well with science. The grade 5 SNB score predicts variation in grade 5 writing and math scores above and beyond that accounted for by the grade 4 writing and math score (i.e., grade 4 as a covariate). Evidence that writing skills benefit from SNB use is larger gains in writing scores for students whose teachers participated in an extensive PD program on SNB use. The largest writing gains were with low achieving students. The

SNB instrument reveals that PD needs to emphasize higher-level thinking, and making connections between kit activities and major principles in science.

S1.7.3 Promoting Reform-Based Science Teaching through the Use of Web-Based Technology Lessons

Moses K. Ochanji, California State University

This study sought to establish the level of use of web-based technology when teachers are intentionally provided with, and supported to use, technology in instruction and the extent to which the choice and use of the technologies promoted reform-based science teaching. Six teachers participating in a year-long professional development program were introduced to the levels of inquiry teaching, reviewed a variety of web-based technologies available at their school site developed and taught technology integrated science lessons Data collected included teachers responses to the technology integration tasks, lesson plans, assessment of the teachers' lessons on the level of inclusion of each of the five essential features of classroom inquiry, and teachers written reflections. The teachers' initial goals for integrating technology in the lessons outlined objectives that primarily sought to have students develop technology skills. However, when challenged to refocus their thinking and analysis of their technology use based on the essential features of science inquiry their instruction goals shifted towards using technology as a means to teaching scientific inquiry rather than as an end by itself. Findings suggest that meaningful integration of technology can facilitate inquiry teaching but the success of such integration require purposeful planned support to the teachers.

S1.7.4 Examining Science Inquiry Practices in the Elementary Classroom through Science Notebooks

Eric N. Wiebe, North Carolina State University
Lauren P. Madden, North Carolina State University
John C. Bedward, North Carolina State University
James Minogue, North Carolina State University
Michael Carter, North Carolina State University

Current research and reports on classroom practice indicate an ongoing need for professional development in elementary science education. The purpose of this research is to investigate the efficacy of science notebook analysis as a vehicle for informing this professional development, with a particular emphasis on guiding teachers in using student-produced graphics more effectively. A purposeful sample of 32 science notebooks from a single elementary school were analyzed for graphic content based on a research-based taxonomy. The results of the analysis show a non-uniform distribution of graphic production across stages of the inquiry. The graphics produced were also largely teacher-driven and represented concrete, macro-scale, real-time phenomena. The paper concludes that this analytic approach has considerable value in informing elementary science professional development.

S1.8 Strand 4—SC-Paper Set: Development of Critical Thinking Skills in Secondary Science

S1.8.1 Evaluative Thinking Capability within Two Cultures: A Case of Secondary Science Education

Tami Levy Nahum, University of Haifa-Oranim, Israel
Ibtesam Azaiza, University of Haifa-Oranim, Israel
Naji Kortam, University of Haifa-Oranim, Israel
David Ben-Chaim, University of Haifa-Oranim, Israel
Uri Zoller, University of Haifa-Oranim, Israel

Society is continuously coping with Science-Technology-Environment-Society (STES) complex issues. In these contexts, the need and relevance of the development of students' higher- order cognitive skills (HOCS) such as question-asking, critical system thinking, evaluative thinking (ET) and decision-making (DM) capabilities within science teaching have been argued by several science educators for decades. Three main objectives guided this study: (1) establishing 'base lines' for HOCS capabilities of 10th -grade students' (N=388) in the Israeli educational system (2) delineate within this population, two sectors; with respect to their ET capability: Arab sector (N=201) and Jewish sector (N=187); and (3) finding - via research – whether purposed ET-promoting teaching may result in gains in the ET capability of the students involved via pre-post questionnaires in the middle and in the end of the school year 2008. We have just started to analyze the collected data; the results will be presented at the upcoming NARST annual conference. Based on our previous studies, we suggest that a long-term persistent application of purposed ET-promoting teaching strategies is needed in order to succeed in affecting, positively, high-school students' ET capability. The need of science teachers' active at involvement in the development of their students' HOCS capabilities is thus apparent.

S1.8.2 Teachers' Meanings and Intentions in Constructing Concept Maps While Learning to Teach Semiconductors

Marissa Rollnick, Wits University
Fhatuwani Mundalamo, Wits University
Shirley Booth, Wits University and Lund University

In this paper we present a phenomenographic analysis of 19 concept maps produced by 7 teachers at various stages of a self study project where they learnt to teach the topic of semiconductors to their grade 10 and 11 classes. The outcome space revealed four categories of description, viz. Fragments of semiconductor knowledge, frames of personal understanding of semiconductors, frames of teaching context for semiconductors, and frames of content for teaching semiconductors. The last category proved to be the most interesting as it suggested that the teacher saw the process of learning the content and learning to teach the content as intertwined. This finding was considered as important in understanding how teachers learn new content for teaching.

S1.8.3 Design Study Methodology to Develop an Intervention to Enhance Scientific Argumentation Skills of Middle School Students

James D. Ellis, University of Kansas
Janis Bulgren, University of Kansas
Kathy Carlsen, University of Kansas

The poster presentation will include information about a design study being conducted with support from the National Science Foundation. The project started June 1, 2006. The project is appropriate for NARST, because it is shares our use of design study methodology in designing, developing, evaluating, and refining prototype materials for teacher education in the area of student scientific argumentation. We will report on how a research group consisting of 14 middle-level science teachers, two master science teachers (as research assistants), and two educational researchers (a science teacher educator and a special education researcher) collaborated over three years to inquire, design, explore, refine, test, develop, and evaluate materials to assist middle school science teachers and students in infusing into classroom activities instructional materials and strategies for developing scientific argumentation skills. The project will produce a set of professional resources on scientific argumentation – the Argumentation and Evaluation Intervention (AEI) -- consisting of the following elements: 1. Argumentation and evaluation strategy. 2. Argumentation graphic organizer. 3. AEI Teachers' Guide [This material is based upon work supported by the National Science Foundation under Grant Number -- NSF 0554414.]

S1.8.4 A Distributed Knowledge Community for Science Teachers: The Impact of Peer Exchange and Reflection Tools

Cheryl-Ann Madeira, University of Toronto
James D. Slotta, University of Toronto

This paper presents a study of twelve science teachers as they iteratively plan, enact and revise a technology- enhanced lesson. The goal of the study is to enhance the opportunities for teachers to reveal their own Pedagogical Content Knowledge (PCK), and provide opportunities for their further development of that vital form of knowledge. Two interventions are introduced where teachers reflect on their planning, enactment and revisions, as well as interact with peers in a community. Cultural Historical Activity Theory (CHAT) is employed to analyze the connections between the activities that science teachers engage in and their development of PCK.

S1.9 Strand 5—SC-Paper Set: The Pedagogical and Career Path: Graduate Teaching Assistant to PhD Scientist

S1.9.1 Situating the Preparation of Graduate Physics Teaching Assistants in Their "Funds of Knowledge" and Leveraging Their Potential as Agents of Critical Change

Sreyashi Jhumki Basu, New York University
Allen Mincer, New York University

A large number of university physics programs require or advise undergraduate students to enroll in recitation sections taught by graduate teaching assistants. These graduate teaching assistants have limited and varied access to preparation in pedagogy. Meanwhile, despite recent gains, in the United States, women and minorities are under-represented in physics classes and physics-related careers. The purpose of this study was to use case study methodology to explore the teaching philosophies and practices of first-year physics graduate

physics teaching assistants as well as their experiences in a course on physics pedagogy. We analyzed our data by generating codes in areas that were of a priori interest to us and by allowing codes to emerge from the data, through a process of grounded theory. The findings of the study suggest that the graduate physics teaching assistants vary greatly in the "funds of knowledge" that they bring to their teaching practice. Also, we found that while the graduate teaching assistants were often aware of the under-representation of minority students and women, they were unlikely to see themselves as key agents in making change in the representation of students, and unable to articulate teaching strategies for addressing social justice issues in physics.

S1.9.2 Relating Motivational Orientation to Indicators of Success for Physical Scientists

Zahra Hazari, Clemson University
Geoff Potvin, Clemson University
John Almarode, University of Virginia
Robert H. Tai, University of Virginia

An analysis of survey data from 3220 PhD graduates in chemistry and physics is performed in order to correlate five goal orientations with six career indicators of success (annual salary, grant funding, first-author publications, and three self-ratings of success). As suggested by our earlier interviews, the data confirms that individuals who exhibit an "Academic Performance Orientation" do not have statistically higher salaries, levels of grant funding or numbers of first-author publications; while they do rate themselves higher in two of the three self-ratings. On the other hand, individuals who exhibit an "Academic Learning Orientation" have higher rates of grant funding and have more first-author publications. Three other orientations are also shown to have interesting correlations with the six outcomes. Additionally, there are gender differences in the prevalence of some of these orientations, and females generally have lower salaries, numbers of first-author publications, and self-ratings of success.

S1.9.3 Lesson Study in the Undergraduate Context: A Case of Graduate Teaching Assistants in the Sciences

Sharon Dotger, Syracuse University

This paper describes a semester long lesson study process with eight graduate teaching assistants (GTAs). The lesson study was conducted to respond to an increasing interest on the part of these GTAs and their supervising faculty for an improvement in the teaching of introductory courses. Data was collected via group planning notes, journal entries, interviews, and teaching observations and analyzed through an inductive process of constant comparison. Findings suggest that GTAs difficulty with lesson planning complicates the lesson study process, particularly with regard to their ability to gather data on student involvement during the lesson. Furthermore, some GTAs were persistant in their perspective that lesson difficulties were the fault of the students, while others began to look to factors associated with the design of the lesson itself.

S1.9.4 Reform in Undergraduate Science Laboratories: Beliefs and Practices of Graduate Teaching Assistants Following Participation in a Teacher Certificate Program

Tracie M. Addy, North Carolina State University
Margaret R. Blanchard, North Carolina State University

Exposure to reform-minded practices in the university sector is limited. Such teaching behaviors are based upon constructivist theory and promote a more student-centered classroom. The instructional belief systems and practices of graduate teaching assistants (GTAs), who lead large numbers of university courses and laboratories, are not well-understood. This multi-case pilot study describes life science GTAs who independently taught science laboratory courses. Each of the participants recently completed a GTA professional development certificate program led by a biology professor with reform-minded beliefs. This qualitative investigation asks: What are the epistemological teaching beliefs of the GTAs? How are their practices described? Do their teaching beliefs correspond with their practices? GTAs were interviewed to capture and describe their teacher beliefs upon completion of the program and their laboratory teaching videos were analyzed to describe their practices. Findings suggest that although the GTAs of varying backgrounds held differing, mostly transitional, teacher beliefs, each displayed similar laboratory behaviors, characterized by Schwab's Level 1 and Colburn's Guided inquiry. Significant contributory factors included the constraints of the laboratory curriculum. Both curriculum design and professional development for GTAs within the culture of college science teaching are implicated in this study.

S1.10 Strand 6—SC-Paper Set: Perspectives on Educators in Informal Settings

S1.10.1 Teaching and Learning with Do-It-Yourself Science Kits in School

Leonie J. Rennie, Curtin University of Technology
Christine Howitt, Curtin University of Technology
Rosemary S. Evans, Curtin University of Technology
Fiona E. Mayne, Curtin University of Technology

As part of its outreach programs a science centre has developed several comprehensive Do- It-Yourself Science Kits available on loan to schools, particularly those located in geographically isolated areas of the state. This paper reports an investigation of how one of these Kits, relating to Astronomy, was used in four middle school classes in different schools. Data collected included interviews with teachers in all four schools, together with observations of a sequence of lessons designed in collaboration with one of the teachers. Although the main aim of the research was to determine the effectiveness of this Kit in terms of how it was used and how its use might promote science learning, broader questions concerning the science education value of such Kits were also addressed. Do these Do-It- Yourself Kits really help teachers to teach science in a way that promotes learning? Or are they just "teacher-proof" sets of equipment and worksheets which engage students in an enjoyable hands-on, but not necessarily minds-on, science learning experience?

S1.10.2 Informal Science Institutions as Incubators for Science Teachers: Documenting Identity Development in Floor Staff

Preeti Gupta, New York Hall of Science
Laura Saxman, CUNY

Floor facilitators who work in informal science institutions become well-versed at teaching diverse audiences in low-stakes settings. This paper focuses on a group of such facilitators working in a science center who are interested in science teaching careers. It describes how shifts in their identity as science teachers occur as they continue their work as facilitators and proactively engage with diverse audiences using inquiry-based teaching methods. Their experiences working with the public and reflecting about those experiences in cogenerative dialogues allows them to explore the theory they learn in coursework, to review and revise their strategies day after day with different curricula and different student dynamics and develop habits of mind so that they begin to feel comfortable, competent and confident with science teaching. Findings document how facilitators gain an increased efficacy in inquiry-based teaching, develop a heightened awareness about their worldviews and issues of diversity and articulate how to vary their pedagogical approach based on audience. This study demonstrates that becoming aware of the unaware, propels identity development as an educator for these floor staff and that the unique structures created by the particular field of an informal learning venue provoke such reflexivities.

S1.10.3 Why Do They Do It? Identifying Factors That Characterize Teachers Who Use Informal Science Institutions

James Kisiel, California State University, Long Beach

Although several national agencies (including NSTA and the Institute for Museum and Library Services) describe the importance of utilizing community resources such as informal science institutions (ISIs) to support science instruction in schools, a growing body of research suggests that many teachers have difficulty taking advantage of such resources (including fieldtrips, outreach programs and teacher professional development). This preliminary investigation is unique in its examination of multiple contexts—the teacher's personal context, as well as the institutional contexts of the school and ISI—that may potentially influence teacher decision-making and science instruction. Nearly 130 experienced teachers were surveyed via both closed- and open-ended questions, to learn of their current use of ISIs, their prior experiences and beliefs toward science teaching and ISIs, and conditions at their school. The findings presented suggest several personal factors, including teaching outcome expectancy beliefs and memories of active fieldtrip experiences, may be related to a teacher's reported frequency of ISI use for fieldtrips and other instructional needs. These findings suggest the need for future studies to clarify such links, and point to possible strategies for ISIs and teacher educators who wish to promote the use of community science resources as part of the class curriculum.

S1.11 Strand—SC-Paper Set: Community, Context, and Informal Issues in Preservice Science Teacher Edcuation

S1.11.1 Science Teacher Retention in Today'S Urban Schools: A Study of Challenges and Opportunities

Hedy Moscovici, California State University

This study is based on data collected over six years (12 semesters) in the secondary science methods courses at an urban university in Southern California. The secondary science credential candidates were teaching on emergency permits or internship credentials in local urban secondary schools. They taught science during the day while pursuing their teaching licenses in the late afternoons Power relationships, urbanity, and critical pedagogy lenses were critical in analyzing the data. Multiple data sources such as the credential candidates' written assignments, verbal communications, and field notes during classroom observations were triangulated. Findings suggest that secondary science interns tend to thrive in schools where there is a perceived cohesive vision regarding science education and efforts of all the stakeholders in the educational community (teachers, students, administration, community including parents, district personnel, university instructors, and the science education research community) are focused on reaching a common goal. However, efforts are wasted where there is no cohesion, and frustrated players in the educational community tend to blame each other for the lack of positive results. Implications of these situations on the interns' attitudes and actions are further explored.

S1.11.2 Authentic Contexts in Preservice Teacher Education: Student and Parental Involvement through Culturally Relevant Science Teaching

Cherie A. McCollough, Texas A&M University

This two year study involving an Hispanic Serving Institution examined how over 300 preservice teachers' participation in Family Science Learning Events (FSLEs) affected feelings of self-efficacy in science instruction to diverse, low socio-economic student and parent populations by using culturally relevant science activities. Results suggest that using FSLEs as an integral component of teacher preparation can be a powerful facilitator of learning for all involved. Future educators were given the rich opportunity conceive and implement culturally relevant science activities and observe science learning in progress with students and their families. Preservice teachers personally witnessed the students' and parents' level of content knowledge, as well as their excitement for learning. Session participants will receive documentation of ideas for conception and implementation of FSLE's, project ideas and references, relevant websites, illustrative student work, and other pertinent materials.

S1.11.3 Fostering the Development of Effective Science Teachers through Community-Based Service-Learning

Neporcha T. Cone, University of Miami

The purpose of this study was to investigate the effects of community-based service learning (CBSL) on preservice elementary teachers' beliefs of the characteristics of effective science teachers of diverse students, as well its effects on preservice teachers' personal self-efficacy about teaching science to diverse students. Data were collected using pretests-posttests and semi-structured interviews with the study sample. Findings suggest that preservice teachers who participated in CBSL developed beliefs about the characteristics of effective science teachers that are complimentary to the descriptions of effective teachers of diverse students provided in the literature. CBSL also significantly influenced preservice elementary teachers' personal self-efficacy.

S1.11.4 Transforming Science Teacher Preparation by Bridging Formal and Informal Science Education: A Focus on Drawings as Evidence

Randy McGinnis, University of Maryland
Phyllis Katz, University of Maryland
Emily Hestness, University of Maryland
Kelly Riedinger, University of Maryland
Amy Dai, University of Maryland
Rebecca Pease, University of Maryland
Gili Marbach-Ad, University of Maryland
Scott J. Dantley, Coppin State University

This study highlighted the use of an adapted Draw-A-Scientist Test (DAST) to gain insights into an informal component of an elementary teacher preparation program. The study took place within the context of an NSF-funded teacher preparation project that included an informal science education internship in prospective teachers' professional development. The central research question of the study was: To what level of success and for what reasons do field-based placements in afterschool informal science education programs that serve adolescent students affect the recruitment (and preparation) of college students, particularly those who are members of under-represented groups, to be science specialist upper elementary/middle level teachers? We asked the diverse interns (N=28) to draw two perspectives, "Draw Yourself Teaching Science" and "Draw Your Students Learning Science." These two prompts allowed us to analyze the pre- and post-test similarities and differences between two perspectives: the viewpoints of the teachers and their perceived view-points of their students. Our findings suggested that bridging formal and informal science education in teacher preparation by use of an afterschool internship impacts prospective teachers' attitudes, sensitivity to diversity, and perspectives on the use of manipulatives, inquiry, and student collaboration.

S1.12 Strand 8—SC-Paper Set: Teacher as Researcher

S1.12.1 Working to Describe Teacher Development: What Happens as a Result of Research Experiences for Teachers

Sherry A. Southerland, Florida State University
Barry Golden, Florida State University
Yavuz Saka, Florida State University
Patricia Dixon, Florida State University
Ellen Granger, Florida State University
Patrick Enderle, Florida State University

Because the reforms call for a very different portrait of science teaching and learning than many current teachers experienced, professional development of science teachers becomes essential. The goal of this research was to describe changes in science teachers as a result of participation in two Research Experiences for Teachers programs. The knowledge, beliefs and teaching practices of two groups of teachers (total 22) were described before and after participation in an RET summer program. A number of instruments were employed for this description: RTOP of teaching videos, TSI, STEBI, BARSTL, and TOSRA. Limited changes were discerned from comparison of the means between groups before and after the programs, although greater changes were observed in individual data.

S1.12.2 An Investigation of Teachers' Motivation, Expectations and Changes to Teaching Practices due to RET Professional Development Involvement

Margareta Pop, North Carolina State University
Patricia Dixon, Florida State University

The present study investigated teachers' motivation, expectations and changes to teaching practices after participating in a six week summer professional development program. Participants (n=67) attended the Research Experience for Teachers (RET) program at the High National Magnetic Field Laboratory (Mag Lab) at a major university in the southeast. Surveys and interviews were used to collect data. Survey results indicated significant differences between Elementary Education (EE) teachers and Middle & Secondary Education (MSE) teachers with respect to their expectations and changes to teaching practices due to their RET program involvement. Follow-up interview results provided more depth to understanding participants' views of their RET experiences, as well as differences between the two sub-samples. Implications for professional development and science teacher education are discussed in relationship to the current study findings.

S1.12.3 Conditions That Support Teacher Learning: An Examination of A Collaborative Action Research Project Using A. Complexity Framework

Xavier Fazio, Brock University

This paper presents a study describing conditions found within a collaborative action research project that promoted science teacher learning. By the end of the project, all participants had developed a better understanding of scientific inquiry and nature of science, and the collaborative group evolved as a learning community. Using a qualitative and interpretive methodology, the views and actions of middle and secondary school science teachers are analyzed demonstrating characteristics that can be ascribed to complexity theory. A post hoc analysis provides evidence of the robustness of complexity theory and its applicability to analyzing science teacher in-service groups. A framework is provided as a tool for the development of professional science teacher collectives, and recommendations are offered for facilitators to use complexity as a framework for designing in-service learning communities.

S1.13 Strand 10—SC-Paper Set: Issues in Performance and Standardized Tests

S1.13.1 Standardized Science Tests: Are We Testing Content Knowledge or Reading Level?

Adam Mitchell, Diamond Fork Junior High
Nikki L. Hanegan, Brigham Young University

The No Child Left Behind Act of 2001 requires states to create standardized science assessments and report the proficiency of all students, including: English language learners, students with disabilities, racial and ethnic minorities, and economically disadvantaged students. However, the fairness and validity of such tests and their results depends on the absence of construct- irrelevant variance (CIV). Reading level has often been cited as a source of CIV on tests designed to measure content knowledge constructs. This paper reviews research on the impact reading level has on standardized science assessments, the accommodations that are being used to eliminate reading level CIV on science tests, and current measures states are taking to avoid reading level CIV on statewide end-of-level science assessments. Correlation data from one school suggest the results of standardized science assessments may test reading constructs in addition to science content knowledge. States are encouraged to do more to ensure the validity of standardized science tests is not compromised due to the reading level of the test items. Additional research is needed to determine which accommodations will most effectively eliminate reading level CIV on standardized science assessments.

S1.13.2 Mapping the Linguistic Landscape of Science Performance Assessments: Opportunities and Challenges for English Learners

Jerome M. Shaw, University of California Santa Cruz
George C. Bunch, University of California Santa Cruz
Edward R. Geaney, University of California Santa Cruz

Our research is designed to shed light on both the linguistic opportunities and challenges that English Learners encounter on performance assessments such as those used in inquiry-based science classrooms. We report on the development of a conceptual framework for understanding the language demands of performance assessments. The framework, grounded in functional views of language and language use, seeks to contextualize grammatical and lexical demands by focusing on the participation structures utilized in performance assessments, the associated modes of communication, and the text types and genres that students are called upon to read and produce. We use this framework to document the range of language demands present in the performance assessments that accompany three 5th grade science units. We also comment on the particular challenges EL's might encounter in all three units, along with the opportunities for language development that accompany those challenges.

S1.13.3 What Types of Cognitive Demands Do Standardized Testing Items Place on Students?

Amelia W. Gotwals, Michigan State University
Hayat Hokayem, Michigan State University
Tian Song, Michigan State University

This study outlines the development of a coding system to examine the cognitive complexity of released standardized assessment items. After describing the design and rationale for the coding scheme, we present results from our analysis of 212 released items from state, national and international sources and compare the types of knowledge and abilities required to successfully complete assessment tasks from different sources and from different grade bands. Our findings indicate that different sources of items have different proportions of item formats as well have items designed to elicit different types of processes from students. In particular, many state assessments have more restricted item formats such as multiple-choice whereas national and international assessments have more extended items types. In addition, items designed for students in higher grade bands tend to give students more opportunities to demonstrate complex reasoning skills such as explaining in extended writing formats. These results have implications for the interpretation of assessments as to what students know and can do in science as well as for assessment designers about how the complexity components of items influence their functioning.

S1.13.4 Modifying Performance Assessment Tasks according to Level, Structure, Transfer, Sequence, and Organization

Joe Engemann, Brock University
Anne Wright, Canisius College
Rodney Doran, State University of New York at Buffalo
Ethel Petrou, Erie County Community College
Joe Zawicki, Buffalo State College

This presentation will describe the development, testing, and revision of performance assessments that assess concepts and inquiry skills within middle and high school biology, chemistry, earth science, and physics. The assessments have been developed to reflect variation along a continuum of complexity with several cognitive and/or instructional dimensions. The dimensions are level (middle school, high school, or advanced placement), structure (highly structured, semi-structured, or unstructured), transfer (very near transfer, near transfer, or far transfer), sequence (traditional, begin with data collection [given plan], or begin with analysis [given data table]), and organization (integrated, independent, or surrogate).

S1.14 Strand 11—SC-Paper Set: Beyond Technique: Language in the Science Classroom

S1.14.1 Reloading and Repositioning Science Language for ELL Students: A New Look At Sheltered Instruction

Molly H. Weinburgh, Texas Christian University
Cecilia Silva, Texas Christian University
Tammy Oliver, Texas Christian University
Valerie Weilard, Texas Christian University

While academic language development is critical for all students, supporting the acquisition of this type of Discourse (Gee, 2004) becomes essential for the increasing number of immigrant students enrolling in schools in the United States today. Programs such as Sheltered Instruction (SI) systematically integrate language and content objectives. However, we hypothesize that language should emerge from the science lesson and be re- loaded and repositioned each subsequent day, rather than up-loading language prior to instruction which is often seen in SI. In addition, 'Discourse' should be modeled for students and practiced by students. Therefore, this research examines science Discourse development as two cohorts of recent immigrant, ELL students ages 9-11 participate in a summer school experience that used erosion as the academic focus. During a 3-week period, we '…married scientific activities with scientific ways of using words rather than with lifeworlds languages' (Gee, 2004, p. 25). We used qualitative methodology to collect and analyze data. Data from student written and oral use of language suggests that they were using Discourse that is consistent with a distinctive culture or community of practice – in this case, scientific Discourse.

S1.14.2 Coming to Terms with Language: The Translation of Technical Terminology in Science Textbooks

Cassie F. Quigley, Indiana University
Alan Oliveira, University of New Albany- SUNY
Gayle A. Buck, Indiana University

The purpose of this study was to explore the challenges that science curriculum translation creates in dealing with science technical words that cannot be easily translated from English to Khmer. This study focused on the efforts of a bilingual geology professor who translated the science textbook from English to Khmer. The primary data sources the original English version, the Khmer translated version, and the back-translated version. Our data analysis included comparative text analysis, which included back translation of the target text into English and systematic comparison of the source and target texts. Our comparative text analysis revealed the five different translation techniques described by Fawcett (1997): (1) borrowing; (2) transposition; (3) modulation; (4) synonymy and (5) literal translation. The conclusion was by using a variety of techniques and incorporating the strategies most appropriate for the target language, they were focusing on both cultural and linguistic differences of the target and source language. Also, through the use of word pairs and repetition throughout the text, they provided their students with an appropriate way to learn the new technical words. The findings have the potential of demonstrating how to use this approach to analyze implementation of translated text in the classroom.

S1.14.3 Isn't that just good teaching? : Language, Identity, and Science Teaching & Learning

Bryan A. Brown, Stanford University
Salina Gray, Stanford University
Bryan Anthony Henderson, Stanford University

All discourse practices are inherently embedded with the sociocultural politics associated with using a genre of talk. As a result, students may encounter feelings of cultural mismatch as they encounter the discourse of science. In light of this dilemma, this study explored the evolution the notion of Discursive Identity as a framework for informing science education. Using mixed methods that include discourse analysis and descriptive statistics we identified how language shaped opportunities for participation. We also identified how students developed a hybrid mode of discourse in an effort to master the language of science. Finally, we identified how students who were taught using everyday language resources initially retained information at nearly a rate of 15% greater than their counterparts who were taught using science language. The results of this study suggest an empirical need to consider how science language is impacted by the mode of language used by the teacher.

S1.14.4 Learning Science and English using Native-Language Aids

Stephanie A. Touchman

This study examined the impact of providing language supports for English language learners within an online science inquiry. The experimental version of the project allowed students to freely switch the paragraph text language and support language between English and Spanish. Using a statistical analysis we were able to determine that English language learners benefit from using their native language as a support to aid in their science learning. This study addresses conflicting findings about the optimal combinations of linguistic supports for students learning a second language. More broadly, this study contributes to ongoing debates about the role of students' native languages in the classroom.

S1.15 Strand 12—SC-Paper Set: Technologies Enhancing Formative Assessment Practices

S1.15.1 Supporting Learners' Reflection through Comparing with Other Learners' Thinking: Development and Evaluation of Reflective Mapping Software

Akiko Deguchi, Utsunomiya University, Japan
Etsuji Yamaguchi, University of Miyazaki, Japan
Hideo Funaoi, Hiroshima University, Japan
Shigenori Inagaki, Kobe University, Japan

In this study, we propose a new software to induce learners' reflection. In previous research to support learners' reflection, there were many kinds of technologies that support learners to "refer to other learners' thinking". To strengthen the effectiveness of this support, we developed a software that support learners to "leverage other learners' thinking," that means leveraging other learners' perspective in reflecting their own thinking. We believe that technology that directly supports leveraging other learners' thinking in reflecting on their own thinking could induce learners' reflection more strongly. To develop a software that supports leveraging other learners' thinking, we made a extensive modification on our previous software to support learners' reflection (Inagaki et al., 2001), and implemented following two functions; "search function" that search appropriate others' thinking to leverage, and "compare function" that indicate the difference between the others' and the learner's own thinking. The results of comparative experiment showed that, compare function induced learners' own reflection through examining others' thinking regarding the difference between two maps more often than the software without compare function. So, it can be said that the software we developed in this study induces learners' reflection through leveraging other learners' thinking in learners' own reflection.

S1.15.2 Teachers' Implementation of a Classroom Response System for Performing Formative Assessment in Secondary Science/Math Classes

Hyunju Lee, University of Massachusetts Amherst
Allan Feldman, University of Massachusetts Amherst
Ian Beatty, University of Massachusetts Amherst and University of North Carolina at Greensboro

This study reports on how science and math teachers learn to implement Technology- Enhanced Formative Assessment (TEFA) using a classroom response system and identifies factors that impede that implementation in secondary schools. We found that teachers struggled with external factors (which are the contexts or conditions where teachers are situated in and which physically obstruct them to implement the technology into the pedagogy) and internal factors (which are the natural and fundamental aspect of a teacher and are originated within him/her). The external factors are 1) technical malfunctions, limitations, and technical support, 2) time and curriculum pressure, 3) students' attitudes and abilities, and 4) structure of the PD program. The internal factors are found to be two separate types. The first consists of teachers' knowledge and skills needed to 1) operate the technology, 2) develop TEFA questions, 3) integrate TEFA into curriculum, 4) orchestrate classroom discussion, and 5) practice formative assessment. The other type consists of their perspectives, beliefs, philosophy, attitudes, fears, doubts, uncertainties, background and experiences of the teachers, which we call their ways of being a teacher. The interaction between the external and internal factors resulted in the development of their individual "situated TEFA practice" in their comfort zone.

S1.15.3 Applying Computational Metaphor Identification to Middle School Students' Writing about Cellular Reproduction

Eric Baumer, University of California, Irvine
Lindsey E. Richland, University of California, Irvine
Bill Tomlinson, University of California, Irvine

Metaphors allow students to grasp abstract concepts they cannot touch or see directly, but they can also lead to cognitive constraints and misconceptions. Fostering an awareness of such metaphors is a crucial step in developing expert-like, flexible scientific conceptual understanding. This paper describes a novel text analysis system for identifying potential metaphors implicit in students' writing. Computational metaphor identification (CMI) was integrated into a web-based inquiry science module to analyze seventh grade science students' responses to a series of questions about the processes of cellular reproduction (mitosis and meiosis). Based on the hypothesis that people regularly link bodies and buildings metaphorically (Lakoff, Espenson & Schwartz 1991)□ , CMI was used to look for metaphors framing concepts of cellular reproduction in terms of concepts from the domain of architecture. The computationally identified metaphors indicate that students may be using a variety of metaphors, for example, a cell is like a building. These results suggest that CMI could be a powerful tool, not only allowing teachers and researchers to determine what metaphors students are using, but also encouraging students to reflect critically on the metaphors they use and consider potential alternatives.

S1.15.4 Dynamic Assessment Tools for Dynamic Constructs: The Case Of Molecular Reasoning

Dalit Levy, Center for Educational Technology, Israel

This paper examines dynamic molecular visualizations from two points of view: (1) learning to explain scientific phenomena by referring to the molecular world with the aid of such visualizations (2) using dynamic visualization tools within assessment tasks in science education. We place our account of both points of view within the scope of technology-enhanced science education, suggesting that the same technology that supports in making thinking visible for the science learners themselves can be used for making thinking processes assessable and measurable. The first section reports the results of a study aimed at exploring the advantages of dynamic visualizations for the development of better understanding of molecular processes. The second section describes two dynamic tools that enable students' demonstration of their molecular reasoning skills in an efficient and novel method and thus let assessors have a glimpse into student understanding. The scope of using dynamic visualization tools both for learning and for assessment may reach far beyond the specific case of molecular reasoning into other scientific and non-scientific areas.

S1.16 Strand 14—Symposium: Views of the Environment – Theory, Measurement, and Results

Bruce Johnson, University of Arizona
Riley E. Dunlap, Oklahoma State University
Franz X. Bogner, University of Bayreuth
Michael Wiseman, University of Bayreuth
Constantinos C. Manoli, University of Arizona

Environmental education programs have long focused on people's views of the environment. The body of literature on the effects of education on these views, though, has suffered from the lack of clear theoretical frameworks and appropriate valid and reliable measurement instruments. In this symposium, we will examine two theoretical frameworks and their accompanying measurement instruments. First, we will look at the challenges of studying views of the environment and the need for better theory and measurement tools. Next, Riley Dunlap will explain the development and use of the New Environmental/Ecological Paradigm (NEP) Scale over the past three decades. Constantinos Manoli will show how that instrument was modified for use with children and present its use in evaluating educational programs and studying the development of environmental beliefs. Franz Bogner and Michael Wiseman will follow to introduce the Model of Ecological Values and the 2-MEV instrument, developed and tested in 20 countries in Europe and northern Africa. Bruce Johnson will then present results of the use of that instrument with children in the US. Finally, participants and audience members will discuss issues of both theory and measurement.

S2.1 Publications Advisory Committee Invited Session—Engaging with Teachers around Science Education Research

Carla Zembal-Saul, Penn State University
Julie Luft, Arizona State University
Scott McDonald, Penn State University
Felicia Moore, Columbia University
Barbara Crawford, Cornell University
April Luehmann, University of Rochester
Tamara Nelson, Washington State University
Celestine Pea, National Science Foundation

It can be argued that one of the grand challenges in science education today is the need to become more effective at bridging the persistent research–practice divide. Not only is there a need for science teaching to be more research-informed, but also for our research to be more practice-based, or at the least practice-relevant. The Publications Advisory Committee, Research Committee and External Policy and Relations Committee invite NARST members who are interested in research–practice connections to attend this session and share their experiences and ideas related to engaging with teachers around science education research. Rather than discuss how research can be translated for teachers in order to impact practice, the focus of this session is on research-based endeavors involving collaboration among science educators and classroom teachers. A brief framing of the session will be followed by a series of interactive posters highlighting "images of the possible," as well as practical challenges associated with this line of work. Ample time will be dedicated to group discussion. Invited guests from the National Science Teachers Association and the National Science Foundation will be on hand to provide insight into the related initiatives of those organizations.

S2.2 Strand 1—Symposium: Multiple Perspectives on Problem Solving in Physics

Kenneth Heller, University of Minnesota
Chandralekha Singh, University of Pittsburgh
David Rosengrant, Kennesaw State University
Frances A. Mateycik, Kansas State University
Leonardo Hsu, University of Minnesota
Jennifer Docktor, University of Minnesota

Problem solving is an integral part of human experience. Thus, research on how students solve problems is an important subfield in STEM educational research. Research on problem solving in physics alone is a vast field with several different aspects and nuances; each of which has been studied in detail by several researchers over decades. A general overview of problem solving in physics can be found in the literature and is beyond the scope of this symposium proposal. Rather, the presentations in this symposium will provide a diverse set of perspectives on current research on problem solving in physics. We emphasize that the symposium will by no means provide an exhaustive overview of all of the current issues and perspectives on problem solving in physics. Rather, we will present a sampling of some of the current work that is at the forefront of research on problem solving in physics.

S2.3 Strand 2—SC-Paper Set: Culture, Social Context and the Discourse of Science Education

S2.3.1 Utilizing the Three C's for Urban Science Education: Cogenerative dialogues, Coteaching, and Cosmopolitanism in the Science Classroom.

Christopher Emdin, Columbia University

In urban settings, where the majority of students are of a low socio-economic status, and where low- performance in science is prevalent, effective science teachers -who lead students to perform well on traditional science markers, foster active participation in science, guide students to meeting federal and state mandates/standards, and develop science interest in students are sparse. Engaging in a study to address teacher effectiveness and student achievement by utilizing three distinct tools has supported both teachers and students in urban science classrooms. Through the use of mechanisms rooted in student interactions, this paper describes how students and teachers gain insight on effectively teaching and learning science and enact practices that support this endeavor.

S2.3.2 Multimodality and Inscriptions: Essential Components of a Multi-Representational Framework to Study Student Discourse

Kok-Sing Tang, University of Michigan

Based on two emerging theoretical concepts of multimodality and inscription, this paper presents a multi-representational framework that accounts for how scientific meanings are constructed through the use of multiple representations in a science classroom. The framework is used in a case study to investigate the discourse and meaning-making process of a group of sixth graders as they constructed an explanation pertaining to a nanoscience concept. A systemic-functional linguistics (SFL) and social semiotics perspective is used to analyze the multimodal discourse of the students' interactions through their use of verbal, visual, and gestural modalities in a chain of inscription activities. Results indicate that the development of students' ideas about the scientific concept is made possible only through the connection of certain critical multimodal resources used in the representations. The value of this framework and analytical approach for science teaching and learning is also presented.

S2.3.3 Science Fairs & Emotions: A Discursive Approach to Anxiety

Giuliano Reis, University of Ottawa
Liliane Dionne, University of Ottawa
Louis Trudel, University of Ottawa
Leonard Klein, University of Ottawa
Chantal Helliwell, University of Ottawa

Anxiety is a significant element of school science. However, little is known about the role it plays in the context of science fairs, considered important extracurricular components for the development of a positive emotional attitude towards science and science-related careers. It explains: the anxiety inherent to participation in science fairs can curb participants' science enthusiasm, thus being counterproductive to the development of scientifically literate citizens. Therefore, the present study investigates how a group of students account for the sources of anxiety that are associated with the different stages of their involvement in a national science fair competition in Canada and how it mediates their participation. Implications for science curriculum and instruction design are discussed.

S2.3.4 A Model for Investigating Social Contexts with respect to Culture and Race: Examining Contextual Foundations on Instructional Practices

Eileen C. Parsons, University of North Carolina at Chapel Hill

I propose a conceptual framework that addresses socialization with respect to culture and race. The conceptual framework, synthesized from the work of others, is applicable to social context broadly (e.g., commonalities in human development) and narrowly (e.g., particularities specific to social identifiers like race and their corresponding positionalities). The objectives of this paper are to present the conceptual framework and use it in one case study. In the case study, I examine the dominant instructional practices of an African American female who teaches middle school science. The practices are examined in relation to her life experiences and worldview. Specifically, in this paper, I address what practices dominate her middle school science classroom and what are the contextual foundations of these practices. Understanding the foundations of teachers' practices can provide insights on how to alter instructional practices and how to successfully implement reform.

S2.4 Strand 2—Symposium: Critique to Learn Science

Hsin-Yi Chang, National Kaohsiung Normal University
Douglas Clark, Arizona State University
Michael Ford, University of Pittsburgh
Victor Sampson, Florida State University
Iris Tabak, Ben Gurion University of the Negev
Roger Taylor, Vanderbilt University
Keisha Varma, University of Minnesota
Beat Schwendimann, UC Berkeley

Critique is central to science and other activities. From a cognitive perspective, critique involves generating criteria and reflecting on how the criteria apply to a task, experiment, situation, or other activity. From a social perspective, critique serves to maintain the criteria or standards of the field. As science educators, we are interested in how to nurture students' critical response skills. This session explores (1) what students learn through critiquing activities, (2) what activities should proceed or follow critique activities, (3) what factors influence students' performance of critique, (4) what criteria students use to critique, and (5) how students' criteria get applied or revised. Several themes are made apparent by the set of papers in this interactive poster session: (a) Learning from critique activities seems to be closely connected to learning contexts; (b) Learning from critique needs to be scaffolded through instructional design; and (c) The quality of critique strategies used by students is influenced by their beliefs. By presenting results across domains and settings, the symposium provides insights for science educators to inform future research directions on critique activity. Furthermore, the interventions provide examples for science instructors to incorporate critique activities in real classrooms.

S2.5 Strand 4—SC-Paper Set: Examining Issues in Science Education at the Secondary Level

S2.5.1 A Summer Institute as a Tool to facilitate NSF GK-12 Program Preparation

Xiaobo She, Texas Tech University
Jennifer A.Wilhelm, Texas Tech University
Darrellee R. Clem, Texas Tech University

Little research has been down to explore the effects of preparation activities (i.e., summer institutes) on NSF GK-12 programs even though they are widely acknowledged as an essential component. This paper is aimed at investigating the participants' cognitional (defined as perceptual and conceptual) development through the summer institutes of the GK-12 "Building Bridges" program using an interdisciplinary and inquiry-based learning framework. A mixed-methods approach was used to collect and analyze data in order to exhibit the participants' development in four areas: mathematics and science integration, communication, patterns of teaching, and beliefs about K-12 education. In essence, the preparation activities were crucial to support a GK-12 program's subsequent success.

S2.5.2 Experiencing Integration: Changes in One NSF GK-12 "Building Bridges" Cohort

Darrellee R. Clem, Texas Tech University
Jennifer A. Wilhelm, Texas Tech University
Xiaobo She, Texas Tech University

This paper describes the changes within one GK-12 cohort from our recently funded NSF "Building Bridges" grant over the course of a week long summer institute during which participants experienced integrated science, technology, engineering, and mathematics (STEM) curricula. A total of 18 participants were divided into three groups of four and one group of six creating a total of four cohort groups from which a focus group was selected. A mixed methods approach was used to track development and communication of group interactions concerning integration of STEM disciplines. The summer institute acted as a catalyst for change, clarifying roles of teachers and Fellows, aligning program goals, and stimulating ideas for the development of integrated curriculum.

S2.5.3 The State of Science Education in Rural, High Poverty and Minority Schools

William R. Veal, College of Charleston

The purpose of this paper is to describe the state of reform-based science teaching in rural, high poverty, low income secondary schools in the southeast United States. Science reform-based teaching is characterized by inquiry teaching and learning, probing questions, collaborative discussions, hands-on activities, and student-centered exploration. Fifteen rural counties and 47 secondary (6-12) science teachers participated in this study. Results on the Reformed Teaching Observation Protocol were compared to student achievement results on state-mandated tests. Results indicate that there was little reform-based science teaching based upon five pedagogical domains. Caucasian teachers taught in a more reformed-based manner, and minority teachers had a better rapport with the students. Direct instruction was a major mode of instruction in most classes. Licensure and certification emerged as a distinguishing factor for contextualizing the potential use of reform-based teaching in rural schools. Several external forces, such as state mandated tests, influenced how and why teachers may have implemented reform-based instructional methods. Results indicated that students scored higher on state-mandated tests whose teachers taught in a more reform-based manner. Many of the teachers did not apply science content knowledge to the local community or culture in the form of real-world elaborations.

S2.5.4 Revealing Tensions between Curriculum and Teachers' Visions of Communities of Science Practice

David J. Grueber, Wayne State University

Grounded in sociocultural studies of teachers' beliefs, knowledge, and practices of inquiry- based science, this study draws on a socio-linguistic approach to compare and describe teachers' and students' contributions to science knowledge and inquiry practices in order to empirically explore how teachers' commitments and resources shapes the classroom community of practice. This study addresses the following questions: What did scientific knowledge and practice look like in each classroom? What do the teacher student interactions reveal about the social norms and sources of authority in the classroom? What were the teachers' commitments and resources to science content and practice that influenced their curriculum construction? The sites of my research are three middle school classrooms implementing a next generation curriculum materials, Investigating and Questioning the World through Science and Technology (IQWST). The study employs interpretive and discourse analytic methods to conduct in depth case studies of three teachers' curriculum construction. This study shows that three unique hybrid communities of practice result from a mixture of commitments to purposes of schooling and instructional strategies, and personal resources in terms of science content knowledge and pedagogical strategies for distributing participation. Implications of this study can inform questions related to improving curriculum design principles and professional development.

S2.6 Strand 5—SC-Paper Set: Societal Issues in Science Instruction

S2.6.1 Nature of Science: A Look into Biology Undergraduate Knowledge

Marie C. Desaulniers Miller, North Dakota State University
Lisa M. Montplaisir, North Dakota State University
Gerald L. Ketterling, North Dakota State University

Science educators have the common goal of helping students develop scientific literacy, including understanding of the nature of science (NOS). University faculties are challenged with the need to develop NOS understanding in three major student subpopulations: future science educators, science majors, and non-science majors. In this study, student NOS views were evaluated using the Student Understanding of Science and Scientific Inquiry (SUSSI) questionnaire (Liang et al. 2006) in undergraduate biology courses. Analysis of quantitative aspects of the SUSSI show limited change in student NOS understanding through an Environmental Science course, little difference between scores of upper-level science and non-science majors, and more informed rankings of science education students compared to science and non-science majors. Across groups, students scores on six subscales of NOS understanding were significantly different, showing notably uninformed understandings of the distinction between scientific theories and laws—a view also evident in exam responses. Comparison of SUSSI subscale scores across gender and laboratory participation show limited differences. Evidence-based insights into student learning can aid in reforming undergraduate science courses and will add to faculty and researcher understanding of the impressions of science undergraduates are forming, helping educators improve scientific literacy in future scientists, teachers, and diverse college graduates.

S2.6.2 College Students' Conceptions of Stem Cells, Stem Cell Research, and Cloning

James P. Concannon, Westminster College
Marcelle A. Siegel, University of Missouri-Columbia
Kristy L. Halverson, University of Missouri
Sharyn K. Freyermuth, University of Missouri-Columbia

This was a mixed methods study designed to understand the types of misconceptions students hold concerning stem cells, stem cell research, and cloning during a biotechnology course. Data were collected from 96 undergraduate students enrolled in two successive semesters of an introductory non-science-majors biotechnology course at a large, research extensive, Midwestern university. We found that the college students had several problematic preconceptions about stem cells, stem cell research, and cloning. A short summary of these includes: a) embryonic stem cells can be implanted into a woman's uterus to produce a baby; b) only animals have stem cells; c) stem cells are found in a human fetus, but not in a human adult; c) adult stem cell research is not currently funded by the federal government; d) adult stem cells are not currently used in any therapies; e) non- living things, such as rocks, have stem cells; f) reproductive cloning is commonly used to help individuals have children; g) adult stem cells come from adults, and embryonic stem cells come from babies; and h) both embryonic and adult stem cells are unspecialized.

S2.6.3 Risk Perception and the Knowledge Deficit Model: Nanotechnology Undergraduate Education

Grant E. Gardner, North Carolina State University
M. Gail Jones, North Carolina State University
Amy R. Taylor, University of North Carolina at Wilmington
Laura Robertson, North Carolina State University
Jennifer H. Forrester, North Carolina State University
Denise Krebs, North Carolina State University

This exploratory study changes in risk and benefit perceptions of university students following three instructional approaches on the topic of nanotechnology. Surveys and interviews were used as mixed methods tools to evaluate student risk perceptions both before and after the instructional interventions. Significant quantitative differences were found in the benefit perception of students receiving the instructional approach discussing both nanotechnology content and societal issues. Qualitative differences were seen in the concerns that students had for particular nanotechnology risks. Implications of this study on nanotechnology curriculum development and the knowledge deficit model are discussed.

S2.6.4 The Development of Biodiversity Curriculum

Hui-Ju Huang, California State University Sacramento
Yu-Teh K. Lin, National Taiwan University

The study presents the processes of developing biodiversity curriculum. The first part was to investigate undergraduate students' attitudes toward biodiversity by using a survey questionnaire. The overall students' attitudes, gender difference and difference between students with or without experiences of conservation activities were analyzed. In summary, students recognized the importance of protecting biodiversity. They agreed that the goal of conserving biodiversity would not be a threat to the continued economic prosperity. However, they also showed conflict attitudes between the need of exploitation of natural resources and the conservation of wildness and wildlife populations. They did not agree that science & technology can solve all problems of biodiversity issues. They recognized that problems of biodiversity issues should not be left to the experts, but they were not confident that they will make a significant contribution to solve problems of biodiversity issues. The implications of the study suggest that there is a need to prepare students for actively taking responsibility on biodiversity issues. The second component of the study was to apply interdisciplinary approach to develop biodiversity curriculum which aims to help students determine their own pathways to sustainable living based on well-informed and critical decision making.

S2.7 Strand 6—SC-Paper Set: Perspectives on Museum Staff and their Influence on Science Learning

S2.7.1 Museum Educators' Views about Nature of Science

Gary M. Holliday, Illinois Institute of Technology
Norman G. Lederman, Illinois Institute of Technology
Martina Nieswandt, Illinois Institute of Technology

Little in the literature speaks to what museum educators know and, in particular, specifically addresses the views they have about Nature of Science. This study attempts to address this gap in the research. Museum educators were asked to fill out an online version of the Views of Nature of Science - Form C (VNOS-C) questionnaire and 20 fully completed surveys, along with their interview responses, were selected for qualitative analysis. Full-time educators, actively teaching science to the public, participated and a wide range of informal science settings, experiences, professional and educational backgrounds were represented. As seen in their responses, the participants of this study exhibited a strong interest and knowledge about science. Furthermore, the ability to talk about science, scientific concepts, individuals, and professions in science was quite evident. The surprising result in the current study was that those who were previously classroom teachers demonstrated less of an ability to talk about science and had more content related misconceptions. This was not isolated to these two individuals however; these misconceptions were seen throughout participants' responses. Participants' views about scientific models, theories, laws, and the certainty of science raise a concern about their ability to communicate about science at their institutions.

S2.7.2 Staff Members' Considerations about Visitors' Learning and the Scientific Content of Exhibitions

Eva Davidsson, Copenhagen Aarhus University
Anders Jakobsson, Malmö University

Science and technology centres (STC) have been criticized for displaying a too product- oriented and single dimensioned image of science. Also empirical studies support this critique and conclude that a common image displayed at STCs is the usefulness of science which emphasizes scientific and technical products and the use we have of them in our society. But why tend this image of science to be the most common? In what ways do the assumptions of the staff members affect the final content and design of exhibitions? The aim of this study is to explore how staff members at STCs consider the scientific content and in what ways may staff members' views of visitors' learning affect the final content and design of exhibitions. The study is mainly based on interviews of staff members, who all were responsible for planning and constructing new exhibitions at their STC. The results of this study suggest that staff members tend to consciously avoid displaying controversial or ambiguous aspects of science as this risk questioning the creditability of their institution. Furthermore, the results reveal an experience-based approach to visitors' learning which tend to exclude enjoyment or creating an interest as learning.

S2.7.3 How Do Staff Members in Science and Technology Centers Consider the Impact of Sponsors on the Scientific Content of an Exhibition?

Helene Sørensen, The Danish University of Education at Århus University
Eva Davidsson, Copenhagen Aarhus University

Sponsors have become increasingly important for exhibition construction during the latest decades. In fact, several science and technology centres and museums are dependent on financial contribution of sponsors. The cooperation between sponsors and the staff members risks clashes and differences of opinions concerning what and how the scientific content is to be displayed. This can be seen from the results of the study reported here as the respondents, who in the questionnaire stated that they used sponsors in their latest exhibition, experienced interference from sponsors with both the content and the design of their exhibitions. The results also reveal that the issue about sponsors' impact on exhibitions is complex as they may influence the exhibitions indirectly and directly. Indirect impact refers to implicit demands where staff members account for what they believe are views of the sponsors. Direct impact refers to sponsors' wish of being visible in the exhibition or demands concerning the content of the exhibitions. There seem to be a trend towards homogenisation of exhibitions, where it is difficult to put specific demands. This is also explicit in this study, where one respondent argues that it is difficult to display controversial issues, while being dependent on external financing.

S2.7.4 Re-Examining the Theory and Practice of Scaffolding in Informal Learning Settings

Doris B. Ash, University of California, Santa Cruz
Judith Lombana, Museum of Science & Industry, Florida
Thao T. Mai, University of California, Santa Cruz
Wendy Dickinson, Museum of Science & Industry, Florida

The focus of this paper, scaffolding, has been studied within classrooms (Cazden, 2001; Wood, Bruner & Ross, 1976) but less researched within informal learning sites. In this paper we highlight the inter-related work of four researchers who actively re-examine scaffolding by focusing on how families and museum educators make meaning of science in a large urban science center. Our research deliberately focuses simultaneously on family sense making as well as museum educator researcher (MER) reflective teaching practices. We address specific areas of interest that rely on scaffolding theory and practice: how families 'figure out' and scaffold each other, how museum educator researchers "notice" social interactions (van Es, 2005) in order know how and when to scaffold. We also as discuss how mixed method research design strategies allow us to reliably capture and analyze complex digital data. We offer a dynamic, mutualistic and inter-related, rather than hierarchical or linear, scaffolding. These interpretations inform our view of complex scaffolder/scaffoldee relationships (Granott, 2005), which then help explain how family members figure out how to do an exhibit and museum educators learn to notice (van Es, 2005) when to scaffold.

S2.8 Strand 7—SC-Paper Set: Inquiry, Design and Art in Preservice Teacher Education

S2.8.1 Guided Peer Discussions as a Scaffold for Developing Learning Progressions about Inquiry

Meredith A. Park Rogers, Indiana University
Cassie F. Quigley, Indiana University

The purpose of this self-study was to examine the use of guided peer discussions as a scaffolding technique to support preservice elementary teachers to understand two of the five features of classroom inquiry. Data sources included: student journals, interviews, instructional artifacts and field notes. Four learning progressions were identified across the six representative participants. These learning progressions included patterns representative of: a rolling hill, a gradual incline to an eventual plateau, a continuous incline, and a paused incline. From the student interviews four themes emerged to illustrate how the guided weekly peer discussions supported their learning progressions. These themes included: 1) appreciating different perspectives, 2) making sense of their ideas through the comfort of peer interaction, 3) understanding there is a social aspect to science, 4) being metacognitive about their experience. The conclusion of this study was the participants learning progressions grew at a positive rate throughout the 6- week experience and that guided peer discussions played a tremendous role in supporting this growth. Implications for scaffolding preservice science teachers' experiences with inquiry learning and teaching will be discussed.

S2.8.2 Use of Hypothesis Testing in First Inquiry Lessons Taught by Elementary Pre-Service Teachers in a Science Methods Course

Barbara Sullivan-Watts, University of Rhode Island
Barbara Nowicki, University of Rhode Island
Betty J. Young, University of Rhode Island
Robert Pockalny, University of Rhode Island

Conceptual learning in inquiry-based science lessons is closely linked to the quality of the scientific process skills taught. This study evaluated the practice of 27 elementary education majors in a science methods course during their first science lessons, focusing on their use of hypothesis formulation, fair test and control of variables. The baseline data will be used in a longitudinal study that will follow them into their student teaching and first in-service years. The analysis suggested that most of the students were not well prepared to present a science lesson that included adequate experimental design. 40% of lessons (Grades 1-5) involved hypothesis testing, with increasing frequency of use at higher grade levels (80- 100% of grade 4 and 5 lessons). For those students whose lessons made use of hypothesis testing there were serious errors in using the experimental approach. For example, only 4% of students demonstrated a well-developed practice of controlling variables during the investigation. Use of a fair test was similarly infrequent. This study indicates that pre-service teachers would benefit from more experiences in scientific reasoning, generating and testing hypotheses, and relating the evidence back to the stated hypotheses and predictions.

S2.8.3 Pre-Service Elementary Teachers' Learning through LEGO Engineering Design Challenges

Ismail Marulcu, Boston College
Michael Barnett, Boston College
Kristen Wendell, Tufts University
Kathleen G. Connolly, Tufts University
Christopher G. Wright, Tufts University
Linda Jarvin, Tufts University
Chris Rogers, Tufts University

In today's competitive world, understanding and using technology and technological tools that were made possible by scientific understanding and engineering design is getting more and more important. With this regard, elementary science education should help students deepen their scientific understanding and provide more engineering education. We believe that deepening science learning and increasing integration of engineering education in elementary levels can be accomplished concurrently with using engineering-based curricular modules including engineering design challenge practices in elementary science classrooms. With this study we hope to advance the knowledge within the educational research community on theory, design and practice in the emerging field of elementary-level engineering education, which we believe can improve elementary-level science learning. To this end, we have been seeking to understand how college students, especially pre-service teachers improve their understanding of elementary science concepts with engineering- based design challenges. An adapted and brief version of the LEGO engineering-based simple machines module is piloted in the study. We used activity theory as our theoretical frame. Our data is collected by using pre- and post- surveys, interviews, observations and laboratory reports. Quantitative results show that engineering-based design challenges improve pre-service teachers' understanding of simple machines, and qualitative results show that there are four tensions identified in students' behavior in the lab sessions.

S2.9 Strand 8—SC-Paper Set: Discourse, Argumentation and Questioning

S2.9.1 The Impact of an Argue to Learn Professional Development Experience on Teacher Content Knowledge and Beliefs about Science

Kent J. Crippen, University of Nevada Las Vegas

A case study method was used to understand the experience of a group of high school science teachers participating in a unique professional development experience of learning science via argumentation. The participants (N=42) represented 25 different high schools from a large urban school district in the southwestern United States. Data sources included a multiple choice science content test and artifacts from a capstone argument project. A focus group interview was used to validate findings and explore further questions. Findings indicate that argumentation pedagogy was successful for building content knowledge related to climate change. Though they initially described themselves as doers of science and were well versed in describing the nature of science, participants were more comfortable in the role of consumers of science. Participant beliefs about the role of laboratory experiences and their lack of comfort theorizing with primary data may be barriers to reformed practice.

S2.9.2 Question Analysis as a Tool to Understand Changes in Inquiry-Based Science Teaching: Strengths and Weaknesses

Margaret Blanchard, North Carolina State University

A central methodological issue in research on inquiry-based instruction is how to compare teaching in science classrooms in which very different sorts of activities are going on. In my dissertation work, I studied nine secondary science teachers who participated in a research experience for teachers (RET) program, and collected pre and post program classroom videotape data. Almost all teachers' lessons, including pre/post, were on different topics, lasted different lengths of time, were at differing grade levels, and/or student ability levels. After spending time in these teachers' classrooms I realized that one ubiquitous element in each classroom was the presence of questions, both the teacher's and students'. I collected data on hundreds of questions that took place between the teacher and the student during one pre and one post program lesson for all nine teachers, and analyzed them. In this paper, I describe the steps I took, decisions I made, show a sample teacher's question analysis, and share some my conclusions. I close with a discussion of the strengths and weaknesses of question analysis, for the reader to decide if this type of analysis might be of use in understanding teachers' changes in classroom practice.

S2.9.3 Variations in the Modality of Science Teaching about Minerals Based on the Discourse Register and Language Code of Earth Science Classroom Discourse

Seung-Ho Maeng, Seoul National University
Chan-Jong Kim, Seoul National University

Recent researches about the language of science classes have not studied linguistic features of science classroom discourse and specific modality of science teaching because of the limit of theories employed. In this study, for the solution of this issue, the discourse register and language code were investigated in case of Earth science classroom discourse. Also, the variation types of the modalities of science teaching were examined according to the transition tendencies of classroom discourses. Additionally, diagrammatic analysis was devised using triangular diagram according to the power relation between discourse subjects, discursive controls, and hierarchical relations. As a qualitative case study, the participant was a middle school Earth science teacher with 17 years' teaching experience. Data included the transcribed discourse texts from four classes about minerals at seventh grade. The variation types of the modality of science teaching were classified into; student- discourse inducement-in-control, student-discourse permission, student-discourse permission- in-control, student-discourse facilitation, and student-discourse enhancement. The teacher failed to develop open relationship with students enough to promote high level of scientific development of students in spite of her intention of student-centered instruction. The consideration of the modality of science teacher's teaching practices through the linguistic analysis of classroom discourse, could offer the supporting point for her professional development in terms of classroom discourse.

S2.9.4 Characterizing Teacher Verbal Interventions as a Baseline for a Personalized Program of Professional Development: The Challenge of Addressing Individual Needs

M. Teresa Guerra-Ramos, Cinvestav Monterrey
Victor H. Lira-Morales, Cinvestav Monterrey
Adrianna Gómez-Galindo, Cinvestav Monterrey

The purpose of this study was to characterize teachers' performance regarding teaching purposes and teaching interventions as a starting point to suggest how teachers can develop and diversify their verbal behavior for effective science teaching. The participants were 5 Biology teachers working in state secondary schools. Each teacher was videotape during four lessons of a unit dealing with respiration as vital function of living beings and its connection to the quality of air and associated environmental and health issues. Three episodes of each lesson were selected for analysis based on the central scientific ideas being addressed. Adopting the analytical framework developed by Mortimer and Scott (2003), we found several categories of teaching purposes and teaching interventions. The case of a male teacher is described to illustrate how the analysis point out some areas of potential development regarding discursive resources. It is argued that analysing teaching episodes with colleagues as a source of insights to improve and diversify discursive resources is an experience that can be incorporated with well defined purposes in strategies for teacher professional development.

S2.10 Strand 9—SC-Paper Set: Action Research

S2.10.1 "Take the Bull by the Horns": Using Action Research to Improve Questioning Strategies
Robert Kagumba, Western Michigan University
Reneé S. Schwartz, Western Michigan University
Emerging from this investigation will be a discussion designed to unpack and further explore, through small and large group conversations, what "evidence" demonstrating the value and impact of ISE might look like. Furthermore, to what extent do answers to this and related questions vary as function of the different communities within ISE, as well as those communities ISE seeks to be a part of (e.g., science education community, education policy community and learning research community)?

S2.10.2 A Teacher Inquiry Project: Chemistry Teachers' Sense-making of Students' Learning within the Context of Community-Based Inquiry Lessons

Youngjin Song, University of Northern Colorado
J. Steve Oliver, University of Georgia

This study investigated how chemistry teachers made sense of their students' learning when participating in a teacher inquiry project by using Video Analysis Tool (VAT) within the context of Community-Based Inquiry Lessons (CBIL). A qualitative case study approach was employed. Multiple sources of data from multiple methods of data collection such as videos, classroom observations, in-depth interviews, and documents were used. Data analysis was carried out in two phases; (1) analysis of video data on VAT and (2) analysis of the interview data and document data. Inductive analysis utilizing grounded theory approach and constant comparative methods was conducted in order to generate themes. The findings demonstrate that the teacher inquiry project provided the chemistry teachers with a window to notice their students' thinking and reasoning that is normally unobserved. Analysis shows that teachers were able to pinpoint specific student's misconceptions, to make sense of how their students cognitively engaged in the CBIL by examining the ways students applied, transferred, and expanded their experiences and knowledge, and to become more aware of students' social interactions in the learning community. Implications for science teacher education programs with regard to potential outcomes from embracing teacher inquiry are presented.

S2.10.3 Examining Evidence-Based Explanations in In-Service Science Teachers' Reflections

Cynthia C.M. Deaton, Clemson University
Thomas R. Koballa, University of Georgia
Lynn A. Bryan, Purdue University

This study examined evidence-based explanations developed by in-service elementary teachers as they reflected on their science teaching practice. Specifically, this study focused on how elementary teachers used the Video Analysis Tool (VAT), a reflection framework, and evidence of their science teaching to develop explanations about their science teaching practice. Open coding was used to analyze participants' data and a case study approach was used to organize the findings. Findings showed participants used multiple evidence categories, such as observatory, experiential, and preparatory evidence, to support explanations developed while reflecting on their science teaching. VAT was used for multiple purposes, such as examining teaching from another perspective, helping students monitor their own behavior, and gathering evidence of other teachers' science teaching practice. Participants were not able to thoroughly address the reflection framework. They struggled with identifying curriculum standards relevant to the focus of their reflection and contradictions between their teaching practice and teaching philosophy. The nature of evidence used by participants focused on nurturing students' emotional needs, examining how students learn, and addressing technical issues of practice. VAT afforded participants the opportunity to identify issues in their teaching practice and develop plans for solving dilemmas in their teaching practice.

S2.10.4 Improving Science Textbook Development through Action Research

Maurice DiGiuseppe, UOIT

Science textbooks contain many misrepresentations about the nature of science (NOS). Current reforms in science education call science textbooks to communicate more informed views of the nature of science. In general, textbooks are developed by authors, editors, and publishers who shape the textbook's contents according to their particular interests and points of view. For future science textbooks to communicate more informed representations of NOS, their developers need to be apprised of current understandings of NOS, and incorporate these into their developing textbooks in the most meaningful and pedagogically appropriate manner possible. This paper reports on a study in which the developers of a chemistry textbook attempted to better represent the nature of science in their book through participation in a collaborative action research project.

S2.11 Strand 10—SC-Paper Set: Formative Assessment in the Classroom and Across the District

S2.11.1 Exploring the Usability of District-Wide Science Assessments by Administrators and Teachers for Improving Science Instruction and Learning

Sanlyn R. Buxner, University of Arizona
Christopher Harris, University of Arizona
Bruce Johnson, University of Arizona

A common criticism of large-scale assessments is that they do not usually provide timely information that can be effectively used by both administrators and teachers. Through a partnership between a large urban school district and a university education research team, we are exploring the usability of district-wide science assessments by multiple levels of stakeholders. The assessments, aligned with learning goals found in state standards and district science curricula, were designed for elementary and middle school classes with both administrative and teacher use in mind. Both levels of district personnel were involved in all steps of the assessment creation and revision. We present results from workshops and interviews with participants at district and classroom levels. We also discuss future steps in how to make the assessment data more useful for teachers in the same year of instruction. Our results suggest that these assessments, aligned closely to state standards as well as district curriculum, have uses both in the classroom and for district facilitators as they plan professional development for future learning of students. Overall, this work has helped us better understand how assessments, learning goals, instruction, curriculum and professional development are independent and mutually impacting.

S2.11.2 When Alignment Matters: A Model for Developing District-Wide Assessments that Align with Learning Goals Embedded in District Standards and Classroom Curricula

Elsa Schaub, University of Arizona
Christopher Harris, University of Arizona
Sanlyn Buxner, University of Arizona
Bruce Johnson, University of Arizona

In this paper, we present a model for creating science assessments that target important learning goals emphasized in classroom instruction and anchored in standards. Developed as an outcome of a three-year collaborative assessment design process involving science education researchers, classroom teachers, and district science coordinators, our model incorporates and extends aspects of a framework for developing aligned assessment items proposed by Project 2061 of AAAS. Our process begins with the identification and clarification of learning goals embedded in standards and classroom science curricula followed by the careful and iterative design of assessment items and pilot testing district- wide. Rasch analysis, teacher feedback and the creation of clarification statements were used to guide item revision that led to an overall increase in the alignment of items to learning goals, standards and district curriculum. We describe key design strategies of our model as well as lessons learned. Findings from our design work show the promise of this model for creating assessments that strongly align with learning goals. Assessments created as an outcome of this kind of careful design work may prove usable by teachers for identifying gaps in instruction or materials, and by administrators for creating professional development opportunities to support classroom teaching and learning.

S2.11.3 Confidence Wagering during Mathematics and Science Testing

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Chia Ju Liu, National Kaohsiung Normal University
James A. Shymansky, University of Missouri at St. Louis
Houn Lin Chiu, National Kaohsiung Normal University

This proposal presents the results of a case study involving five 8th grade Taiwanese classes, two mathematics and three science classes. These classes used a new method of testing called confidence wagering. This paper advocates the position that confidence wagering can predict the accuracy of a student's test answer selection during within-subject assessments. Quantitative analysis of data using the Risk Inclination Model (2008) revealed that female students were more prone to taking risks when making confidence wagering predictions and less prone toward risk aversion as compared to their male counterparts. Qualitative analysis of student comments revealed a positive acceptance of confidence wagering as a good way to self-regulate the point value of selected answers, to assist the teacher and student in refining which areas need more instruction and practice, and to reveal where the student's confidence is incorrectly placed.

S2.12 Strand 11—SC-Paper Set: Addressing the Grand Challenge of…

S2.12.1 The Confluence of Constructivism and Policy toward Intercultural Science Education

Claudia Khourey-Bowers, Kent State University

The purpose of this position paper is to advocate for an intercultural approach to science curriculum, distinct from Western science, which respects personal, social, and intercultural values through a constructivist orientation. Intercultural science education emerges coherently from integration of constructivist theory and international policy issues. A constructivist orientation has the potential to engage learners in transformative processes in which they find connections across their personal lives, empirical knowledge, and Indigenous ways of knowing. The goals of constructivist science education go well beyond acquisition of knowledge to include social and historical contexts for learning. Emerging scientific fields such as ethnobotany, in addition to ecological and environmental studies, have the potential to bridge cultural and intellectual divides. School science which is designed from a constructivist, intercultural vision has the potential to engage all students by merging the relevance and immediacy of Indigenous knowledge with the analytical and replicable nature of Western science. This paper will offer design elements for intercultural science curriculum.

S2.12.2 A Case Study on an Undergraduate Student Interest Socio-Scientific Issues Based Curriculum Intervention

Kelly A. Schalk, University of Maryland

One of the major challenges associated with science education today is understanding how to develop science curriculums that engage and prepare students to become scientifically literate members of society. Given many of the "Grand Challenges and Great Opportunities" science faces this next quarter century, the goal of empowering society with an epistemological understanding of science and the skills to critically evaluate information when making decisions that affect their life is more necessary than ever. Consequently, the most recent science education movement has been focused on emergent learning environments that advance students' curiosity, open-mindedness, and informed skepticism about scientific discoveries. Socio-scientific issues (SSI) curricular frameworks have been promoted to achieve these goals. However, there is a gap in the literature with respect to what is known about SSI treatments on college-aged students and what popular science factors diverse learners are drawn to. This investigation reports the effects of an innovative student interest SSI-based curriculum on a diverse population of undergraduates. Interpretation of the data suggests that a SSI framework, encouraging students to investigate their questions, successfully motivated undergraduates to learn science content, develop Nature of Science (NOS) conceptualizations, and critically evaluate scientific information.

S2.12.3 The Accountability Pressures of NCLB and the Instructional Practices in Minority School Science Classes: Unintended Consequences

Obed Norman, Morgan State University
Charles Ault, Lewis & Clark College
Glenda Prime, Morgan State University
Kevin Cuff, University of California, Berkeley

The No Child Left Behind (NCLB) legislation presents both a grand challenge and a great opportunity for Science Education. The im-

petus behind the NCLB legislation is to ensure more equitable educational outcomes for all students and as such it can hardly be faulted. However, at the classroom level NCLB is largely experienced as an accountability measure that defines student and teacher success almost exclusively in terms of rising test scores. This narrow interpretation of accountability generates pressures for teachers that may have unintended outcomes. One such outcome is that the narrow focus on raising student test scores pressures teachers to adopt 'teach to the test' instructional strategies that may not enhance substantive student learning. The objective of this study was to explore the impact of the No Child Left Behind (NCLB) accountability pressures on the instructional practices in middle and high school science classes in schools with relatively large enrollments of minority students. In this ethnography of school science classes we sought answers to the following research questions. a. How are the instructional strategies of these teachers impacted by the accountability requirements of NCLB? b. How do the enacted instructional strategies compare with strategies that have been identified as holding the most promise for enhancing learning among urban students from economically disadvantaged backgrounds?

S2.12.4 What Does Culturally Relevant Science Look Like? A Delphi Study.

Dawn L. Sutherland, University of Winnipeg

In science education there have been some small and large-scale research programs that examine the characteristics of science teachers that impact culturally relevant science teaching and the implementation of culturally relevant science. Most studies have found that in-service teachers do not change despite interventions that include the incorporation of culture into science. As well, we know from previous research that pre-service teachers tend to be unaware or disinterested in issues related to cultural diversity, they are ignorant of the prejudice they may hold towards other cultures and they are naive of how culture may influence learning. The current study examined the perception of pre-service teachers' understanding of culturally relevant science using a Delphi technique. The final description of culturally relevant science teaching obtained through the Delphi method contained characteristics also discussed in the literature. In addition, the final description by pre-service teaches included references to contemporary culture (kid culture) that other descriptions of culturally relevant science have not. The implications for pre-service instruction on culturally relevant science and future research are discussed.

S2.13 Strand 12—SC-Paper Set: Application of Cognition Theories to Technology-Based Learning

S2.13.1 Language Mediated Haptic Cognition: Exploring the Role of Grounding Terms

James Minogue, North Carolina State University

Rapidly evolving virtual learning environments that push the limits of traditional research methodologies and analyses schemes present a "grand challenge" for many in the field of science education. Current difficulties regarding the accurate assessment of student learning in virtual learning environments are due in part to the complicated interface among words, internal representations, and physical environments. Borrowing from Deb Roy's 2005 semiotic schemas theory, which in part details the importance of 'grounded' words that refer to physical referents using a unified representational scheme, this study presents a novel approach to the assessment of student learning about basic cellular structure and functioning via a haptically-augmented virtual learning environment. By exploring the presence of 'haptically grounded' terms in students' (n = 80) written responses to a cognitive assessment item, this work provides early evidence that language mediates haptic cognition. Given the known importance of written language as psychological tool that bridges the gap between lower and higher mental functions, it is suggested that 'haptically grounded' words function as pointers to concepts in the mind, concepts that are fundamentally different than ones formed form visual and verbal information alone.

S2.13.2 The Influence of Text-Graphic Integration and Individual Differences on Learning from Multimedia Presentations

Michelle Cook, Clemson University
Ryan Visser, Clemson University
Carol Wade, Clemson University

In science education today, multimedia presentations that combine visual and verbal information are widely used for displaying instructional material (Mathewson, 1999). The design of the text-graphic relationship involves both physical and semiotic relations and interaction with the learning task and individual differences; it must be carefully orchestrated to maximize learning. However, educational research has been slow to identify how to effectively design these learning materials. This purpose of this study was to examine how cueing, modality, and redundancy influence how high and low PK participants view and learn from three different multimedia presentations on mitosis.

S2.13.3 The Effect of Two-Dimensional and Stereoscopic Presentation on Spatial Cognition Tasks

Aaron Price, Tufts University
Hee-Sun Lee, Tufts University

Nineteen middle-school aged students visiting a planetarium were presented with three types of spatial tasks in both two-dimensional (paper) and stereoscopic visual environments. The students' performance on tasks was evaluated in order to determine the impact of stereoscopic presentation upon accuracy and task completion time. Results show that accuracy did not differ between the two representational environments. However, there was a difference in completion time. Tasks that were 2D in nature actually took less time in the stereoscopic environment while tasks that were 3D in nature took longer. Task response data and post task interviews show that cognitive load was increased in the stereoscopic environment. Additionally, interviews show that students continued to visualize in two-dimensions while using the stereoscopic representations.

S2.13.4 Self-Directed Physics Learning Using Multimedia in Small Groups

Agnes Szabone Varnai, University of Paderborn, Germany
Peter Reinhold, University of Paderborn, Germany

According to literature, multimedia learning environments on the one hand provide many benefits for students like supporting cognitive processes by multiple representations e.g. of science concepts, stimulating interest or enabling cooperative self-directed learning. They put high demands on the learner on the other hand. Goal of presented field study is to clarify how learning processes in upper secondary physics can be supported by a different degree of self-directed learning using different multiple representations (optional vs. systematic) and by a different degree of coordinating face to face cooperation (with vs. without partner-model). Test conditions were set up applying four different exercise sheets, which are embedded in a normal, multimedia based unit of instruction lasting about six weeks. The unit's topic is kinematics. The problems on which the students are working are embedded in the contexts of sports and traffic. The offered representations to support problem solving comprise videos and a digital videoanalyzer (VIMPS), a spreadsheet for data processing (MS Excel) and an interactive simulation (INTERACTIVE PHYSICS). The results of this recent study are reported.

S2.14 Strand 13—SC-Paper Set: Elementary- and Middle-School NOS: Views, Evolution, and Assessment

S2.14.1 Grand Challenges: Bringing the Relationship between Science and Worldviews into the Classroom

Matthews R. Matthews, University of New South Wales

Because worldviews bear upon so much of the same personal, social and intellectual concerns as education, one might expect that reflection on, and enhancement of, worldviews should be a part of education. Because of the intimate connection between science and worldviews, there is a particular responsibility for science teachers and curriculum writers to address concerns about science, worldviews and education; but there have been theoretical and practical obstacles to doing this. This paper identifies four considerations that make understanding the relationship of science to worldviews, and bringing this understanding into classrooms, a grand educational challenge at the present time; it delineates the ontological, epistemological, anthropological, ethical and theological components of any worldview; it cites examples of the intimate connection between science and worldviews; it indicates the centrality of worldviews for culture; and finally it discusses the strengths and weaknesses of standard options for reconciling science and worldviews where clashes occur.

S2.14.2 Toward an Understanding of the Development of Student Views on Evolution

Ronald S. Hermann, Towson University

A large body of extant literature exists regarding students views about evolution, including the lack of understanding of evolution among students. Unfortunately much of the research regarding evolution education has been conducted at the high school or college level, or with pre-service or practicing teachers. Based on this research it is becoming clear that students' views of evolution ,and, consequently, their understanding of evolution is difficult to change during instruction at the high school or post-secondary level. Much of the extant research suggests students views of evolution are firmly held before high school. However, it may be possible for science educators to decrease anti-evolution views and increase an appreciation for evolutionary theory during the developing years. The experiences students have prior to high school biology may be as important, if not more important to understanding evolution, than the experiences students have during high school biology. There is a critical need for a comprehensive evolution curriculum for the years prior to high school and research regarding the development of students' views on evolution and how they interact with understanding of evolution.

S2.14.3 Florida Teachers' Discomfort with Teaching Evolution: More than Just Religion

Samantha R. Fowler, University of South Florida
Gerry G. Meisels, University of South Florida

Newly revised science standards in Florida now place heavy emphasis on evolution, whereas before it was only slightly mentioned, and this caused a flurry of anti-evolution sentiment throughout the state. Because of this, the purpose of our study was to determine the extent to which Florida science teachers, both elementary and secondary, are comfortable with the now much expanded emphasis on evolution in the science standards. We surveyed 353 elementary and secondary science teachers from throughout the state in order to determine (1) teachers' comfort level with evolution being included Florida's science standards, (2) general attitudes and beliefs about evolution, and (3) the extent to which teachers are criticized, censured, disparaged, or reprehended for their opinions on the teaching of evolution. Results indicate that a surprisingly large number of life science teachers are not comfortable with teaching evolution. While much of this is due to teachers' religious beliefs, conflict with colleagues, administrators, and parents and lack of content knowledge also play a role. Reasons for this and implications for teaching are discussed.

S2.14.4 Model for Assessing Elementary Students' Concepts of Nature of Science

Sufen Chen, National Taiwan University of Science and Technology
Sang-Chong Lieu, National Hualien University of Education
Wen-Hua Chang, National Taiwan Normal University
Shu-Fen Lin, National Chiao Tung University
Mao-Tsai Huang, National Academy of Educational Research

This study investigated a model to assess elementary students' concepts of the nature of science (NOS). A questionnaire was developed based on written responses of 431 sixth graders, student dialogues quoted in master's theses and books related to NOS, and interviews with 12 sixth graders. The items were tested with 1139 third to sixth graders. Fifty-three out of 89 items were selected according to results of item analysis and reliability and validity tests. Exploratory factor analysis revealed 8 factors. Confirmatory factor analysis revealed that both the upper grades (n=575 5th and 6th graders) and middle grades (n=564 3rd and 4th graders) data could be explained by the factor structure. The 8- factor model is recommended for assessing elementary school students' views on NOS.

S2.14.5 Exploring Young Children's Beliefs about Science and Scientists

Tiffany R. Lee, University of Washington

We know that young children acquire a vast amount of knowledge about the natural world through their everyday experiences (National Research Council, 2007). Through these experiences, children begin to develop conceptions about science and the nature of science before they enter school that contribute to children's developing stereotypes and perceptions of the nature of science. These ideas can also affect children's developing identities as scientists, influencing their engagement in science and their desires to pursue science- related careers. This study investigates young elementary school students' perceptions of science and scientists to better understand the knowledge that children bring with them to their school science lessons. Specifically, this study identifies the beliefs kindergarten, first and second grade children have about science and scientists, their reported activities that contribute to their knowledge about science, and how they perceive their own identities as scientists. By identifying what counts as science to these young children and the sources of their knowledge, we will be better prepared to design curricula that incorporates young children's existing science ideas and builds upon their interests in science.

S2.15 Strand 14—Symposium: The Influences of Culture and Nature on the Motivation of Indigenous Children to Learn Science

Eleanor D. Abrams, University of New Hampshire
Chiung-Fen Yen, Providence University, Taiwan
Pauline Chinn, University of Hawai`i at Manoa
George E. Glasson, Virginia Tech
Margarita Cholymay, University of Hawai`i at Manoa
Michael Middleton, University of New Hampshire
Juliann Benson, University of New Hampshire
Absalom D. Phiri, Malawi Ministry of Education, Malawi
Ndalapa Mhango, Domasi College of Education, Malawi
Marilyn Lanier, Virginia Tech

Developing scientific knowledge and fostering an interest in scientific processes and advancements are crucial for the sustainability of societies. In particular, people in agricultural communities who depend on sustenance agriculture with limited technology and educational opportunity may be able to use scientific knowledge and initiatives to support themselves, their families, and communities. Western Modern Science would benefit from Indigenous knowledge and wisdom. However, learning science in school is often dissociated with scientific literacy that is useful in the daily lives of these Indigenous students. Two papers will explore how Indigenous children in Taiwan and Belize are motivated to learn science depending upon the kind of support the students received. The nature of their relationships with teachers, the level of academic support for learning science, and the motivational climate for learning science in their classroom, school, and community were key aspects in their development of identity as science learners. The other two papers will examine the need to integrate Indigenous knowledge and science to address immediate needs within the Indigenous communities of the nations of Chuuk and Malawi. This research elucidates how merging worldviews and hybridized knowledge can be leveraged to create dialogue and curriculum development for children from indigenous cultures.

S2.16 Strand 15—SC-Paper Set: Snapshots: How Science Education Policy is Made (or Not)

S2.16.1 The Evolution of Evolution in Florida's Next Generation Sunshine State Standards for Science

Lance E. King, Florida State University

Abstract The view that science education standards are inherently political documents (Collins, 1998; Kirst and Bird, 1996) is well supported by the story of the Florida Department of Education's recent revision of its Sunshine State Standards for Science. This study is an examination of that process and how the various political tensions among the stakeholders influenced the final product. Particular emphasis is placed upon the state's efforts to elevate the status of biological evolution from a topic that was not addressed by name in the previous standards to a central organizing principle of the life sciences in the new standards, and the fierce opposition that this policy shift engendered.

S2.16.2 A Principal's Instructional Leadership: How does it Influence Elementary Science Amidst Contradictory Reforms

Kimberly S. Lanier, Florida State University
Alejandro Gallard, Florida State University
Sherry S. Southerland, Florida State University

Within the science education literature, researchers recognize that principals are important, and indeed influence science classroom practices. But the nature of the principal's role in terms of the science program is not fully understood. This investigation examined the dynamic interplay between an elementary school administrative team (principal and assistant principal) and science teachers, in an effort to understand (1) what do principals do in terms of science, (2) how does what they do impact teachers' science instruction, and (3) how does the instructional leadership employed by the principals impact the science program. The findings indicate that, because science teachers felt that the principal was doing what was in the best interest of students, they worked tirelessly toward the successful attainment of the school's vision for science. This was problematic because the school's vision conflicted with the goals and vision espoused by AAAS and NRC on many levels. The principals were open, receptive, and dedicated to enhancing students' science experiences; however, they were unaware of national science education reform efforts. Therefore, what happens in an elementary science program when leaders conceptualized as effective, are uninformed? This and other questions will be examined.

S2.16.3 The Small School Movement and its Impact on Science Education in New York City

Keith Sheppard, Stony Brook University
Angela M. Kelly, City University of New York

The new smaller school policy is the centerpiece of New York City's school reform and began as a replacement strategy for large, failing high schools. Since 2002, more than 250 new secondary schools have been created. While most research on small schools is positive, focusing on such issues as increased graduation rates, the impact of the movement on science education especially the physical sciences has not been addressed. The purpose of this study was to detail the effect of the small school movement on student access to and enrollment in physics courses across the City. Using data collected directly from high schools in the city the study shows that few of the newly created small schools actually offer physics as a course. A series of recommendations are made to modify the policy to include more physical sciences in the smaller schools' courses of study.

S3.1 Strand 1—Poster Session

S3.1.1 Do Student Teachers Use the Same Conceptual Change Mechanism for Changing a Given Alternative Conceptions?

Mohamed Moustafa Ali, Alexandria University, Egypt
Medhat Ahmed Elnemer, Alexandria University, Egypt
Robert E. Yager, University of Iowa
Magda Habashi Soliman, Alexandria University, Egypt
Ahmed Kamel Elhussary, Alexandria University, Egypt
Fatma Fatouh Elgazar, Alexandria University, Egypt
Nabeel Abd Elwahed Fadl, Tanta University

This study investigates alternative conceptions among science student teachers in their final year in the science education department about chemical and phase change and whether they follow the same mechanisms for conceptual change when they have the same alternative conceptions. Quantitative and qualitative techniques were used for this investigation. Multiple choice questions and interviews about events were used for data collection. Moreover, to investigate how student teachers visualize the concepts, they were asked to draw cognitive maps. The quantitative tool "MCQ" was administered to 55 student teachers in the science education department in Alexandria University. In addition, interviews about events and cognitive mapping were conducted to 28 student teachers. Data analysis revealed that although student teachers had the same alternative conceptions, they tended to use different mechanisms for developing conceptual change. Based on these findings, some educational implications of interest for the teaching of science were discussed.

S3.1.2 An Analysis of Conceptual Flow Patterns and Structures in the Physics Classroom

Haim Eshach, Ben Gurion University of the Negev

The aim of the current research is to characterize the conceptual flow processes occurring in whole-class dialogic discussions with a high level of interanimation; in the present case, of a high-school class learning about image creation on plane mirrors. Using Detailed Chains of Interaction (DCI) and Conceptual Flow Discourse Maps (CFDM) – both developed for the purpose of this research – the classroom discourse, audio-taped and transcribed verbatim, was analyzed and three discussion structures were revealed: accumulation around budding foci concepts, zigzag between foci concepts and concept tower. Based on these structures and on two additional factors which affect the discussions and molded the above structures: the teacher's interventions and the conceptual barriers the students evidenced (materialistic thinking and the tendency to attribute 'unique characteristics' to optical devices), the Two Space Model of whole-class discussions is suggested, explaining the whole-class discussion process. This model might help teachers to prepare and conduct efficient whole-class discussions which accord with the social constructivist perspective of learning.

S3.1.3 Future Elementary Teachers Integrating Hypertext with Hands-On Experimentation in A Design-Based Context

Jacquelyn J. Chini, Kansas State University
N. Sanjay Rebello, Kansas State University
Sadhana Puntambekar, University of Wisconsin, Madison

We discuss how future elementary school teachers in a physics class progress through the CoMPASS (Concept Map Project-based Activity Scaffolding System) curriculum that facilitates learning by integrating hands-on and hypertext activities in a design-based context. We report on the criteria that participants use while making design predictions, their navigation strategies on the hypertext system, and what they learn about their design task after completing the hypertext and hands-on activities.

S3.1.4 Middle School Student Understanding of Wind

Eunmi Lee, Dominican University

The purpose of this study is to identify and characterize different types of students' understanding about convection currents as a causal mechanism for generating wind, and the conceptual changes derived from instruction. Instruction, including two concrete phenomenological experiences, a conceptual model construction activity and group discussion, was provided in order to promote a richer understanding of convection currents. The researcher then examined the students' conceptual changes of applying convection currents (a scientific principle) to explain winds (a scientific phenomenon). The data come from four middle school science classrooms (n=90), including pre- and post-tests, interviews, classroom video, students' activity books and artifacts. The findings of this study include a survey of students' preconceptions, misconceptions and procedural errors associated with applying their understanding of convection currents

to explain winds, and the effects of instruction. It is hoped that this study provides further insight into both the nature of students' science learning and the development of effective instructional strategies for activities and lessons related to convection currents and winds.

S3.1.5 "A Day Is When I Play:" How 1st-8th Grade Students Understand the Word "Day"

Danielle B. Harlow, University of California at Santa Barbara
Lauren H. Swanson, University of California at Santa Barbara
Adam Truxler, University of California at Santa Barbara

Understanding what children know is paramount to planning effective science instruction. We use a mixed methods approach to understanding 480 students' (grades 1-8) responses to the question, "What is a day?" - a complex idea for young learners. The initial qualitative analysis allowed us to see trends in the responses. For example younger children provided very personal responses and older students provided more scientific or mathematical responses. The subsequent quantitative analysis highlight ways that ideas are connected in groups of students, ultimately providing descriptions progressively sophisticated responses typical at each grade level.

S3.1.6 An Analysis of Science Instruction in the Fifth-Grade Science Classroom: Investigating Activity-Based Instruction with Student-Generated Discussion

Julie E. Vowell, University of Houston

The purpose of this study was to determine the extent to which debriefing impacted cognitive understanding among students in the fifth-grade science classroom. This mixed methods study involved two intact, equivalent fifth-grade science classrooms ($N = 39$) in a one month study of rocks and minerals. The researcher selected a pretest-posttest control-group design. The pretest assessed the students' prior knowledge while the posttest measured understanding. A similar posttest was administered two weeks later for retention. A t-test for independent samples examined differences on the pretest between the two groups. Likewise, a t-test compared the mean scores on the first posttest (achievement). A separate t-test was performed on the second posttest (retention) and was followed by a Pearson Product Moment Correlation. Classroom observations and a teacher interview added depth to the study. Flanders' Categories for Interaction Analysis was used as a framework for observing social interaction. The quantitative data suggested science achievement of fifth-grade science students who learned through activity-based instruction with debriefing was statistically significantly higher than students who learned through activity-based instruction without debriefing ($p <.01$). Also, student retention was statistically significantly higher ($p<.01$). Additionally, the effect sizes for achievement and retention were large and educationally meaningful.

S3.1.7 Examining the Impact of Evolution Instruction on Understanding and Acceptance of Evolutionary Theory and the Nature of Relationships among Understanding, Acceptance, Thinking Dispositions, and Religiosity

Hasan Deniz, University of Nevada Las Vegas
Chris S. Sefcheck, Coronado High School Las Vegas

Science education researchers have long been interested in exploring the convoluted relationship between understanding and acceptance of evolutionary theory. Some studies reported no relationship between understanding and acceptance, while others reported a positive relationship. Findings of this study indicated that there is no statistically significant relationship between understanding and acceptance of evolutionary theory both before and after instruction on evolution. As a result of instruction on evolution, students' both understanding and acceptance of evolutionary significantly increased. Students' understanding of evolutionary theory was not found to be related to thinking dispositions and religiosity, but students' acceptance of evolutionary theory positively correlated with thinking dispositions and negatively correlated with religiosity both at the beginning and at the end of instruction on evolution.

S3.1.8 Assessing Fifth Grade Student's Ability to Determine the Status of Their Own Conception and Investigating the Effect ff Cooperative Learning on Achievement and Alternative Conception

Donna M. Lewis
David Treagust, Curtin University

This study assesses the effect of cooperative learning in three fifth grade physical science laboratory classes taught by two teachers on achievement and student's alternative conceptions. In addition, the Conceptual Change Model (Posner et al, 1982) was used to investigate student's ability to determine the status of their own conceptions. Data from the administration of two achievement tests the Unit Matter Test (UMT) and Unit Matter Diagnostic Instrument (UMDI) indicated that there were significant differences between the average item mean, average standard deviation, and t-test on the pre and posttest scores for both tests. Pre and Posttest data obtained from the UMDI showed a significant decrease in student's alternative conception. Student's use of descriptors provided varied evidence of their ability to use the technical language (intelligible, plausible, or fruitful) and effectively determine the status of their own conceptions.

S3.2 Strand 2—Poster Session

S3.2.1 Form and Structure of Chinese Characters and Children's Understanding of Science

May Hung, May Cheng, The Hong Kong Institute of Education

Learning science in Chinese is difficult, as the pronunciation is different from the written representation. The written representation can be considered as a pictorial or a symbolic representation. In Hong Kong, students are making translations between the language they use in their daily lives, the science concepts and the scientific terms. The research team designed an interview protocol for primary school pupils in order to find out the pupils' alternative concepts of science, and if these alternative concepts are related to the structure of the Chinese language. Findings suggest that there are alternative conceptions related to a) the form of the Chinese character e.g. the Chinese character for broad bean includes a prefix meaning worm, and so pupils may take it that a worm lives inside the bean, b) the meaning of the Chinese character e.g. an electronic buzzer is a device used to attract bees, as in Chinese the character contains the word meaning bees producing sound. Findings will provide important data for comparing the learning of science using different languages, and on ways in which primary teachers may better facilitate their pupils in learning science.

S3.2.2 Inquiry-Based School Science: University, School and Scientists Partnerships

Lucy Avraamidou, University of Nicosia
Maria Evagorou, Kings College London

Although teaching science as inquiry has been advocated by a number of researchers and reform documents in the world the reality is that there are very few specific examples in the literature illustrating scientific inquiry in practice, especially within the elementary school context. This qualitative single case study aims to address this gap by providing a concrete example of an inquiry-based science project, a partnership between a University, an elementary school and a metrology engineer, regarding a water quality. The research questions that guided the study were the following: a) In what ways did an inquiry-based investigation and the collaboration with a scientist support students' understandings about ecosystems, water quality and fundamental aspects of the work of scientists? b) How did the students perceive the overall experience of the outdoors inquiry-based investigation? The findings of the study indicated that all students learned a great deal through their engagement in the investigation, they enjoyed being outdoors and using various scientific instruments with the help of the scientist to examine the quality of the water and their stereotypical views about scientists were reconstructed because of their interaction with the young scientist.

S3.2.3 NSF-Graduate Fellows and Teachers Engage in Interdisciplinary Learning

Jennifer Wilhelm, Texas Tech University
Darrellee Clem, Texas Tech University
Xiaobo She, Texas Tech University

An interdisciplinary environment was created in a NSF GK-12 institute with 18 graduate Fellows and teachers, where participants investigated, analyzed, and communicated task findings. Using a mixed methodology, we compared differences in mathematics/science efficacy and content understanding between participant groups. We also examined how experiential learning influenced participants' mathematical/scientific actions. Findings revealed no significant differences in content knowledge or self-efficacy issues between Fellows and teachers. We found significant differences between males and females (favoring males) and between science/mathematics discipline groups (favoring mathematicians) on the mathematical items of both content and efficacy assessments. This interdisciplinary setting initiated learners to voice their beliefs and realizations regarding their own mathematical/scientific understandings. Most of the discomfort displayed by learners revolved around their mathematical understandings.

S3.2.4 Exploring Cognitive Engagement in Students Learning Evolution in a Project-Based Approach

Kristin L. Cook, Indiana University
Gayle A. Buck, Indiana University
Meredith Park-Rogers, Indiana University

The purpose of this particular study was to investigate "In what ways did the students engage cognitively in the evolution problem-based learning (PBL) unit?", and "What type of instruction within the PBL unit fostered desired levels of cognitive engagement with evolution?" Data analysis of the cognitive engagement of 70 9th grade Biology students revealed that: (1) Active Student Voice Allowed Students to Reflect on their Positioning on Evolution, (2) Collaborative Relationships in the PBL Both Subdued and Enhanced Cognitive Engagement (3)The Authentic Nature of the PBL Unit Fostered Cognitive Engagement, but was quickly Lost to a Procedural Emphasis (4) Engaging Students in High Level Evaluative Thinking too Soon Inhibited their Understanding of the Theory (5) Summative Assessment Did Not Reflect the High Levels of Engagement Sought Throughout the PBL Unit. These findings enhance our understanding of how to better structure PBL efforts in order foster more cognitive engagement with the theory of evolution. It is unrealistic to simply plunge students into higher level synthesis and evaluation of complex topics such as evolution and expect that learning will naturally follow. Students need to understand and be able to apply their conceptual knowledge so that evaluative judgements can be grounded in understanding.

S3.2.5 Small Group Science Talk in a Design-Based Classroom: An Exploratory Study

Anushree Bopardikar, University of Wisconsin-Madison
Sarah A. Sullivan, University of Wisconsin-Madison
Sadhana Puntambekar, University of Wisconsin-Madison

This paper discusses an exploratory study in which middle school students learned science through small group collaboration in a design-based classroom. The science talk of two groups of students with similar post test performance was analyzed to examine their discourse patterns. It was found that although the groups had performed similarly on the post test, they differed in the quality and extent of their science talk. While one group had more constructive science talk than the other group, students from both groups, in general, engaged less in deep science conversations and processes such as generating questions, predictions, explanations, and were more focused on completing specific tasks such as reading and writing text-based information. This paper discusses contextual factors to explain these findings, as well as implications for constructive science dialogue in teaching and learning of science.

S3.2.6 Understanding Teacher Facilitation of Small Group Interactions in Design-Based Science Classes

Katherine D. Knight, University of Wisconsin-Madison
Sadhana Puntambekar, University of Wisconsin-Madison

Project and design-based curriculum present students with an overarching question or problem that students solve through the design, construction, and testing of an artifact. Understanding teacher facilitation during student use of hypertext as a primary science resource is critical if students are to find success by applying appropriate scientific concepts rather than finding success simply by trail and error. In this study, the dialogic strategies of three middle school teachers are analyzed as they facilitate small group use of the CoMPASS hypertext system within a simple machines curriculum. Chronological representations of dialogic strategies are presented for each teacher during inclined plane and pulley, the first and last simple machine investigated. The representations reveal that the majority of teacher talk is procedural and logistic rather than science oriented during both investigations. A focus on copying information and task completion suggests that teacher's view the use of CoMPASS hypertext as a bounded activity within the curriculum sequence for each simple machine. Identifying and characterizing teacher dialogic strategies during small group work with CoMPASS hypertext represents the first step in a sequence of research aimed at developing teacher professional development and teacher educative curriculum materials in collaboration with classroom teachers under real-world conditions.

S3.2.7 What is Technology? A Theoretical Framework for Investigating Student Conceptions about the Nature of Technology

Nicole DiGironimo, University of Delaware

Although the science education community has made it clear, through the standards and scientific literacy literature, that knowledge of the Nature of Technology should be an educational goal, there is a lack of research on student conceptions about the Nature of Technology. The purpose of this research was to consolidate the literature on scientific literacy, technological literacy, and theories of learning and develop a theoretical framework for investigating student conceptions about the Nature of Technology. The review of the literature led to the identification of three domains of knowledge that completely characterize the Nature of Technology. The theoretical framework for investigating student conceptions about the Nature of Technology was then used to analyze data collected from an exploratory survey distributed to a small group of middle school students. Student responses were coded into themes that represent naïve conceptions about the Nature of Technology. The results suggest that the students sampled do not have a comprehensive understanding of the Nature of Technology.

S3.2.8 Exploring English Language Learners' Perspectives of the Most Helpful Science Activity Centered on Animal Life Cycles

Lisa M. Algee, University of California, Santa Cruz

This study focused on exploring which science activities were most helpful to English Language Learners (ELL) learning of science content, particularly life cycles (butterfly, frog, and human). This research was theoretically informed by sociocultural theory and literature on student learning and science teaching for English Language Learners. A qualitative, holistic perspective was used to explore which science activity ELL identified as the most helpful in their learning: decontextualized, contextualized, hands-on inquiry, parental participation, guest-speaker presentation, and e-mail correspondence. Data from multiple sources was collected: student interviews, student summative rating of activities, and researcher field-notes. All data sources were analyzed for similar patterns and trends. Triangulation was sought through the use of multiple data sources and multiple methods of data collection. To ensure accuracy in the researchers' interpretations of student responses during student interviews, member-checking was employed. This study will add to the literature on students' perspectives of the most helpful science activity for their science content knowledge, particularly animal life cycles.

S3.2.9 Employing a Mixed Methods Approach to Study Urban Science Learning Environments

Gillian U. Bayne, Lehman College of the City University of New York

Given the multifaceted nature of teaching and learning science within an urban setting and the diversity of students and teachers it encompasses, there is a need to study how students and teachers experience their learning environments, so as to better understand and improve them. An integration of quantitative assessments, which afford insights into students' classroom perceptions of their learning environments, utilizing the Constructivist Learning Environment Survey (Taylor, Fraser & Fisher, 1997), and qualitative assessments, including cogenerative dialogues (Roth, Tobin & Zimmerman, 2002), elucidate important and meaningful ways for stakeholders to explore and understand the intricacies of the qualities of life lived in urban science classrooms.

S3.2.10 Promoting Argumentation within Elementary Science Inquiry

Elizabeth Redman, University of California, Los Angeles
Noel Enyedy, University of California, Los Angeles
William Sandoval, University of California, Los Angeles

There has been pressure on the science teaching community both to utilize inquiry curriculum and to promote argumentation among students. However, it is not clear that an inquiry curriculum naturally fosters argumentation among students. This study arose as an effort to explain the lack of argumentation occurring in an inquiry-oriented elementary school science classroom. The authors videotaped and analyzed the classes over a six-month period in which students were engaged in two extensive sensemaking activities as part of the inquiry-based curriculum. The analyses examined the classes through the lenses of task structure and participation structure (Erickson, 1982) in order to understand the extent to which these classroom tasks and structures promoted or inhibited argumentation. The findings reveal that although inquiry curriculum theoretically allows for argumentation, on its own it does not require that students practice it; argumentation was rarely a requirement for completing work, and the curriculum seldom necessitated argumentation as a means for making sense of the information. Consequently, the authors argue that a shift in the discursive environment of the classroom, from making children responsible for getting knowledge to making them responsible for building and evaluating knowledge, is necessary to promote argumentation within the inquiry curriculum.

S3.2.11 The Development of PCK in Science Teachers: Classroom Enactment as a Prompt for Reflection

Cheryl Ann Madeira, University of Toronto
James D. Slotta, University of Toronto

This case study follows the development of pedagogical content knowledge (PCK) in a science teacher as he co- designs, enacts and revises a technology enhanced project-based science lesson. The purpose of this study is to facilitate and make PCK development more explicit for the science teacher. Two interventions are introduced where teachers reflect on their planning, enactment and revisions, as well as interact with peers in a community. This study adopts Cultural Historical Activity Theory (CHAT) to describe and analyze the activities of a science teacher. Reflective action helps the teacher develop cognitive and metacognitive understanding about the process of teaching science and makes connections between PCK and classroom actions.

S3.2.12 A Study of 7th Graders' Critical Thinking Ability and Attitudes about Genetic News

Wen-Hua Chang, National Taiwan Normal University
Katherine Hsieh, National Taiwan Normal University
Pei-Ying Tsai, National Changhua University of Education

This study is to investigate 7th graders' critical thinking ability and their attitudes about genetic news. This study was conducted at three junior high schools in city areas. In stage 1, 275 7th graders were surveyed. Critical Thinking Test-Level (CTT-I) was used to explore the students' critical thinking ability. In stage 2, 213 7th graders form stage 1 participated. The constructs of critical thinking in CTT-I were applied to check students' critical understanding of selected genetic news, and semi-structural interview was used to explore students' understanding of science concepts in the news. Student interview transcripts were analyzed by the constant comparative method. Cross-checking of the data analysis results indicated that: The students' critical thinking test measures are above average; The correlation between scores of critical understanding about genetic news and CTT-I scores is negative; Students' critical understanding may be a function of the text genre; and The 7th graders' attitudes toward scientific news can be grouped as submission, wager, and depending on personal belief. The students are in need of developing a balanced position in interpreting genetic news. Suggestions based on the findings to future researches and science teachings are also discussed.

S3.3 Strand 3—Poster Session

S3.3.1 A Pedagogical Framework for Teaching Science as Inquiry in a Singapore Primary School

Chew Leng Poon, Nanyang Technological University, Singapore
Yew Jin Lee, Nanyang Technological University, Singapore
Aik Ling Tan, Nanyang Technological University, Singapore
Shirley Lim, Nanyang Technological University, Singapore

This study describes a year-long co-development of a pedagogical framework for inquiry science in a primary school in Singapore. The design of the framework sought to reconcile the strengths of teacher-directed classrooms where the fundamentals of science are emphasised and taught coherently with the benefits of a more questioning, inquiry environment. Using design research methodology, the framework was developed "ground- up" from classroom practices. The framework served as a Vygotskian mediating tool for teachers to plan and implement inquiry lessons that not only focus on discrete concept learning but also give attention to connections across concepts and the development of big ideas in science. This responds to criticisms that current inquiry approaches do not strengthen students' knowledge of the fundamental concepts and treats concept learning as discrete disconnected activities. Given that the robust enactment of inquiry science is at its infancy in Singapore, this framework could serve as a prototype to generate further dialogue among the international community of science educators and practitioners who are interested in classroom research that reflects the rich East-West diversity of cultural and scholarly traditions.

S3.3.2 Explanations on Sense Organs and Nervous System: A Content Analysis of Primary School Textbooks

Adrianna Gómez, Unidad Monterrey, Cinvestav
Agustin Adúriz-Bravo, Universidad de Buenos Aires
Maria Teresa Guerra, Unidad Monterrey, Cinvestav
Anna Marba, Universitat Autònoma de Barcelona

Concept maps were applied in the analysis of meaning relations displayed in primary textbooks. We targeted at explanations on sense organs and nervous system. The texts we analysed were extracted from science lessons included in the official Mexican textbooks for primary school (years 1 to 6). We classified the relations using Paul Thagard's categories (class, part, example, property and rule). In the analysed texts, we mainly identified property relations; that is, it is understood that the nervous system has as a property capturing information. Nevertheless, from the point of view of modelling, the model presents certain basic rules of functioning that permit it to show some properties. When the rules of functioning are not presented explicitly, the model is hidden; the text only shows a description of what the system does, but not why it does it, or the regularities that permit to transfer it to explaining other phenomena. Meaning relations generate a text with a multiplicity of functions; some sections are mainly explanatory, others are descriptive or prescriptive. Our analysis aimed at showing strengths and weaknesses in the texts. Our findings suggest several implications regarding the potential of the analysed texts to support teachers and pupils in the elaboration of school science explanations and argumentations.

S3.3.3 The Use of Hands-On Science Materials and Standardized Science Test Scores

Scott A. Ashmann, University of Wisconsin-Green Bay

The purpose of this study was to determine the extent to which the regular use of a hands- on science curriculum (provided by the Einstein Project) influenced the performance of students on a state standardized science test. The Einstein Project is a non-profit organization that partners with schools and communities to provide hands-on curriculum units for science education in Wisconsin. This study was based on a number of comparisons, such as the percentage of students who were classified in either the "Advanced" or "Proficient" categories in school districts that were regular users versus state averages and a similar comparison between school districts that were regular users versus non-users of Einstein kits. The findings from both fourth and eighth grade analyses will be shared along with comparisons to the results of other standardized tests.

S3.3.4 Combining Inquiry and Strategies for English as an Additional Language (EAL) Learners to Promote Use of Science Language by Kindergarten Students

Liesl M. Hohenshell, University of Wisconsin-Whitewater
Lacy Behringer, Lincoln Elementary School

The purpose of this study was to collect preliminary data examining the effectiveness of combining strategies targeted to English as an Additional Language (EAL) students with an inquiry approach, the Science Writing Heuristic (SWH), modified for kindergardeners. Seventeen students (EAL n=9) explored a unit on magnets through an inquiry investigation. Lessons were informed by strategies that are known to work with EAL students (e.g. cooperative grouping and native language use). Teacher instruction, prompts and questioning and the students' conversations were recorded through videotape and transcribed. Conversations were examined to determine the frequency of scientific language used by students. Data was also collected from student work comparing the number of correctly recorded pictures of magnetic objects predicted to those observed. Compared to predictions, three students demonstrated learning gain from the observations, and no student recorded more than one observed item incorrectly. Science language was used by all but one student, (8 EAL and 8 primary English speakers). Of the 242 science words counted, students whose primary language is English used a total of 157, while EAL students used a total of 85. Students demonstrated learning on inquiry tasks in spite of marked differences in language use.

S3.3.5 How Explicit Reflective Instruction Fosters Early Elementary Students' Understandings of Nature of Science

Khemmawadee Pongsanon, Indiana University
Cassie Quigley, Indiana University

This study explored the K-2 students' improvement of Nature of Science (NOS) during the six-week informal science program, which explicit reflective NOS instruction was used as a teaching technique. The purpose of the study is to seek of what extent K-2 students can improve their understanding about the target NOS aspects. Students' responses to the views of Nature of Science FormD (Lederman & Khishfe, 2002) and interview transcription pre and post instructions, students' works, videotapes of each week's instruction, and audio of reflective conversations focusing on students' understanding of NOS between two instructors were analyzed to find how students' views changed. The results revealed the improvement in the understanding of the tentative, inferential, empirical, creative, subjective, and culturally embedded NOS. However, the degree of the improvement varied from aspects to aspects. The instruction most influenced the students' understanding of the tentative science; while subjective science was the most difficult aspect for early elementary students. The students improved their observation and inference skills; however, it is difficult for K-2 students to differentiate the two skills.

S3.3.6 Cooperative Learning in Science Inquiries: Supporting Students' Science Thinking and Social Interaction

Winnie Wing-Mui So, The Hong Kong Institute of Education

This study examines how cooperative learning and teacher scaffolding function for science learning take effect during inquiry activities. As the use of group work in science lessons are in both a practical and a pedagogic consideration, it is reasonable not to view group work as simply dividing students into groups, but to use cooperative learning and teacher scaffolding to promote the kind of interaction and teamwork essentials for scientific inquiry. Teacher scaffolding mainly relies on the design of the inquiry activities to facilitate discussion of ideas among students, and cooperative learning includes various structures of cooperative learning and group process roles. Lesson observations, interviews and questionnaires were used to collect evidence from different aspects of the learning of two classes, with only one of them having adopted cooperative learning in the design of inquiry activities. Analysis of data from different perspectives helped to better understand how students develop science thinking and social interaction during the science inquiry activities, and to capture the differences between the classes with and without cooperative learning. The findings provide insight into the strengths and limitations of using cooperative learning in science inquiries, and can be referred as practical advice for teachers.

S3.3.7 Exploring Korean Children's Imaginary Science Drawings: A Case of Science-art Integration

Kongju Mun
Sung-Won Kim, Ewha University, Korea

Well-integrated science instruction with art often motivates students to more engage in science learning and to freely express their thoughts and feelings on what they have learned in science classes. This study, therefore, attempted to explore Korean children's imaginary science drawings. Ninety elementary students (3rd-6th graders) in Seoul, South Korea, participated in this study. The guiding research questions were 1) what overall characteristics of students' imaginary science drawings are and how these characteristics represent children's image of science, and 2) what educational value of children's imaginary science drawing activity as a case of science-art integration is. Data sources included a set of children's drawings and individual interviews with selected students. From the drawings, it was found that most of the subjects that children drew tended to be limited to the space. In addition, the children tended to assimilate science into technology that makes our life more convenient. We also found imaginary science drawing can be a good science-art integrated instruction method. Imaginary science drawing has educational benefits; one is a tool to investigate children's thoughts and knowledge of science while the other is method that motivates children to learn science effectively.

S3.3.8 Children's Non-Fiction Science Trade Books and Read-Alouds: Their Impact on Science Learning

Dawn L. Sutherland, University of Winnipeg
Donna Haydey, University of Winnipeg

The use of children's trade book in the science classroom is not new. Integration, multimodal representations and whole language are all foci of many current curricula and the primary reason science trade books have been introduced into science classroom teaching. Many of the studies conducted on the impact of children's trade books on science learning have focused on fictional texts. In this study, a repeated measures design was used where a group of 40 students were read three pairs of atypical information books and expository texts to examine the impact each text type had on conceptual understanding. Gender was not found to be a factor. The order in which the texts were read (either expository first, informational second or vica versa) significantly affect the ability of children to respond to certain questions. However, the order was not consistent between sets of books. The application of these findings to match teacher pedagogical intent of the book and book selection will be discussed.

S3.4 Strand 4—Poster Session

S3.4.1 Examining Changes in Teachers' Assessment Practices & Knowledge Development during Technology Enhanced Instruction

Keisha Varma, University of California - Berkeley
Erika Tate, University of California - Berkeley

This work examines how teachers' assessment practices change as they incorporate technology-enhanced curriculum modules in their science instruction. The data focus on changes in their assessment practices and their ideas about assessment, student learning, and instruction. Middle and high school teachers enacted technology-enhanced curriculum modules. Data were collected via individual interviews and classroom observations. Findings show that teachers move from primarily focusing on technology related issues to focusing on understanding and supporting students' knowledge development. Over time, teachers also make more attempts to use the on-line grading tools, and engage in interactive formative assessment. Further findings will be presented about changes in teachers' assessment practices and examine how engaging in interactive formative assessment can increase teachers' knowledge of students' ideas as well as inform and improve their pedagogy.

S3.4.2 Modeling the Epistemic Activity of High School Students in a Physics Laboratory Activity Using Motion Sensors

Ricardo L. De la Garza, Unidad Monterrey Cinvestav
Adrianna Gómez, Unidad Monterrey Cinvestav

The model-based view and how students generate significant meaning about school science models has attracted the lively interest of contemporary science education. Our intention in this research is to generate an epistemological description of the cognitive activity of students, when constructing and validating their knowledge about the school science model of uniform motion. For achieving this goal we present a qualitative methodology that includes four stages: Mapping the epistemic practices of students, to make evident the modeling process of students, generation of a model related to the epistemic activity of the students. We have found eight epistemic practices that can be located in levels according to the modeling process proposed by Ronald Giere. This correspondence between epistemic practices and epistemic levels permitted us to generate a model of the epistemic activity of students when solving a laboratory activity. We found that that the cognitive activity of the students is ample and depends of: the context, the instruments they use and their previous cognitive inventory about the notions of uniform motion.

S3.4.3 Teachers' Perspectives on an Inquiry-Based Evolution Unit

Lara B. Pacifici, University of Georgia
Norman Thomson, University of Georgia

Scientists, philosophers of science, and science educators concur that evolution is an underlying theme of biology. Biology teachers deal with multiple pressures surrounding the teaching of evolution in the classroom, and many teachers rely on more direct teaching methods when they are unfamiliar with evolutionary content. Our study involved the presentation of an inquiry-based unit on evolution in biology classrooms. The goal of this unit was not only to teach students evolutionary concepts but also to increase teacher efficacy for teaching evolution in a way that incorporates inquiry. Our research question was: What are teachers' perceptions of teaching evolution and using inquiry in the classroom after participation in an inquiry-based unit that uses skull replicas to teach evolution? We interviewed six teachers who implemented the inquiry unit in their classroom. In addition to gaining valuable feedback regarding the different aspects of the unit, we found that more experienced teachers were more open to the inquiry approach and more comfortable with the required evolution content than were newer teachers. Curricula such as ours that provides assistance and guidance to teachers in presenting evolution content in an inquiry framework are useful in strengthening their self-efficacy in evolution and inquiry teaching.

S3.4.4 Constructing Pedagogical Content Knowledge: Adopting Argumentation in the Context of a Grade Nine Unit on Heat

Karen C. Goodnough, Memorial University of Newfoundland
Pamela Osmond, Memorial University of Newfoundland

In this study, a small collaborative inquiry group consisting of two high school science teachers and a university researcher adopted argumentation as a teaching and learning approach in the context of a grade nine unit on heat. Pedagogical concept knowledge (PCK) was used as a lens to examine how teacher PCK was contructed and engaged during the adoption process. The specific research questions that guided the study were: a) How will teachers' PCK be constructed as they incorporate argumentation into their teaching of a grade nine heat unit? b) How will teachers' PCK be enacted in planning argumentation activities? and c) How will teachers' PCK be enacted during classroom teaching through argumentation? This study is significant in that it adds to a growing body of research on argumentation and how teachers may be supported when adopting argumentation. It also provides insight into how teachers' PCK is constructed and enacted in practice for teaching a specific topic in science. If teachers are to adopt argumentation, critical to this process is helping teachers engage in reframing so they may construct an understanding of what argumentation is and how it may be used to promote particular goals in science teaching and learning

S3.4.5 Examining Lower Secondary Science (LSS Year 7-9) Teachers' Conceptions of Teaching and Learning Science

Roslena Johari, University of Nottingham, United Kingdom

The study presented here aims at investigating Lower Secondary Science (LSS) teachers' conceptions of teaching/learning and their translation into classroom practices. The primary data sources are audio-taped interviews, video-taped classroom observations and document analyses of lesson plans and class handouts of 5 LSS teachers in a government secondary school. The secondary data source is the collection of responses from a Questionnaire Survey in the form of likert scale of LSS teachers nationwide from all secondary government schools. From the semi-structured open-ended interview data and Secondary Science Teacher Analysis Matrix observational data, the analyses would be an attempt to convey links between LSS teachers' conceptions of teaching and learning and observed classroom practices regarding the teachers preferred teaching strategies and their focus on student or content. The triangulation of all the data would be used to categorise and explain LSS teachers' classroom practices as categorized in Secondary Science Teaching Analysis Matrix. The research design is a case study of an elite secondary school. It employed a mixed methods, mixed methodology approach that combined both inductive and deductive reasoning to draw its conclusion with an interpetivist research approach as the dominant paradigm and the positivistic approach as a secondary paradigm.

S3.4.6 Changes in the Scientific Literacy of Middle Years Students, in Relation to Biotechnology, After Completing an Inquiry-Based Unit

Harry Kanasa, The University of Queensland
Kim Nichols, The University of Queensland

Past attempts to raise the scientific literacy of middle years students have met with varying degrees of success. These have traditionally focussed on only presenting the public with 'facts' on topical issues. The present study has not only focussed on middle years students (12-15 year olds) but also equipped them with the skills to be able to evaluate and analyse media debates on genetically modified crops to come to a personal stance on the question, 'Should Australia grow GM crops?' The concept of interest therefore was the scientific literacy of these students. For the purposes of this research, scientific literacy has been reconceptualised to consist of Attitudinal, Behavioural and Cognitive domains and is described as the AB&C model of scientific literacy. The study proposed that an inquiry-based unit that focussed on both the science and the societal implications of GM crops would positively influence students' scientific literacy as defined by the AB&C model. This seminar will position the current study within the existing literature around student attitudes to biotechnology and discuss the consequent design of the instruments utilised in the study. Findings suggest students' attitudes became more polarised as a result of participation within this unit. Using this novel approach, this study shows that it is possible, at least within a schooling context, to change public knowledge and attitudes towards topical science issues.

S3.4.7 Design, Development and Iterative Refinement of a Module on Electromagnetic Properties of Materials for High School Students

Costas P. Constantinou, University of Cyprus
Y. Hadjidemetriou, University of Cyprus
L. Fakiolas, University of Cyprus
Y. Karmiotis, University of Cyprus

We have developed a module on the electromagnetic properties of materials, which was put through two cycles of implementation in high-school classrooms. Our intention is to develop a mechanism for students to explore the inter-relationships between science and technology in the context of Materials Science. The design of the activity sequence seeks to guide students through an inquiry-oriented approach to first develop the conceptual model of re- orientation of magnetic domains, then apply this model to account for the properties of ferromagnetic, diamagnetic and paramagnetic materials, as monitored through measurements with a Hall effect sensor, and, lastly, to design a magnetic levitation train using electromagnets and explain their design decisions and the mechanism of operation of the train in a detailed written report that addresses the issues of levitation, propulsion and passenger safety. During the classroom implementations we collected data through pre-tests and post-tests, the student written reports, student group posters and an instrument designed for measuring the state of student interest as a motivation construct. Our findings illustrate the value of feedback from student learning in authentic classroom contexts in improving initial designs of curriculum materials and also the potential of integrating design activities in science curricula as a motivator for science learning.

S3.4.8 Investigating the Impact of Teachers' Implementation Practices on Academic Achievement in Science during a Long-Term Professional Development Program

Murat Gunel, Ataturk University
Brian Hand, University of Iowa

This study is a part of a bigger project known as the Science Writing Heuristic (SWH) Partnership Professional Development Project, conducted at the two local universities in association with the State Department of Education to help improve science teaching. Overall, the goal of the project is to help practicing science teachers understand and apply a student-oriented instructional approach, using the SWH. The purpose of this research study was to examine the link between teachers' implementation of a student-oriented teaching approach through the SWH approach with embedded non-traditional writing practices and students' performances on standardized tests over a 3-year period. This study investigated the impact of 6 teachers' implementation of the SWH approach on student standardized test scores over the 3-year period. A mixed method approach was adopted as a research method. Results of the study indicated a differential across teachers in terms of improvement in pedagogical skills related to the SWH approach. Also, results showed that the SWH approach in-service program did have an impact on participating teachers' pedagogical practices. The majority of the participating teachers improved their pedagogical practices of implementing science inquiry through the SWH approach over the 3-year period of the professional development program. Further, when teachers' rankings were correlated against students' standardized test scores, the results indicated that as their implementation levels increased their students' test achievements also increased.

S3.4.9 Applications of Photonics in NYC High Schools? A Hands-On Professional Development Workshop to Increase Teachers' Content Knowledge, Self-Efficacy, and Use of Inquiry Methods

Cheryl Bluestone, Queensborough Community College/CUNY
Paul Marchese, Queensborough Community College/CUNY
Deborah Hecht, CUNY
Catarina LaFata, CUNY

Photonics, the study of optics, lasers, and fiber optics, is one science field where the shortage of qualified personnel is particularly acute and is a national priority. Optics concepts are central to photonics and are part of the New York State physics core curriculum Yet teachers often are not familiar with its many applications to photonics, so do not impart to students a significant appreciation of the field. Further, teachers may not be aware of relatively inexpensive equipment to introduce activities related to photonics and its applications, or they may not have content knowledge to fully utilize existing equipment. PIs will describe a collaborative professional development program for NYC middle and high school teachers to deepen knowledge of links between essential curricular units and how they can be implemented in the classroom in an engaging and investigative format. As part of the professional development program, teachers had opportunities to work in teams to develop and implement activities to HS youth attending a science camp. PIs will present results, which demonstrate teacher gains in content knowledge, and self-efficacy to use inquiry approaches to teach a range of specific photonics-based activities.

S3.4.10 The Relationship between Mathematics Achievement and Chemistry Achievement in a Low-Performing, Urban High School

Susan L. Hunt, Long Beach Unified School District
Susan Gomez-Zwiep, California State University Long Beach

A quantitative study was performed to determine if there was a relationship between chemistry achievement and mathematics achievement in a low-performing, urban high school. There were several measures of chemistry achievement including course grades, individual unit test scores, chemistry CST (California Standards Test) scores, and chemistry EOC (End-of-Course) scores. Mathematics achievement was defined with several measures including algebra I and geometry course grades and CST scores. Algebra I is a prerequisite course for chemistry. The first part of the study examined the relationship between overall chemistry achievement and mathematics achievement and GPA (grade point average). The second part compared scores from individual chemistry unit tests with algebra 1, geometry and GPA. The chemistry units were categorized as either algebra based or non-algebra based. The algebra based units consisted of stoichiometry, solutions, gases and balancing equations. The non-algebra based units were atomic structure and bonding. Results showed that there was little or no relationship between the measures of chemistry achievement and algebra achievement. But there was a consistent relationship between all measures of chemistry achievement and geometry achievement.

S3.4.11 What Happens When Students Work In Groups?

Juanita Jo Matkins, College of William & Mary
Gail B. Hardinge, College of William & Mary
Nancy W. West, College of William & Mary
John A. McLaughlin, McLaughlin Associates

The use of cooperative learning (CL) groups is a classroom strategy that merits critical examination in the light of 21st century issues in science education. Though research on CL in the 1960's and 1970's showed positive affective and social impacts, the science education community has a Great Opportunity to move beyond "if" CL is used, to "how" CL can be implemented to achieve optimum effect, especially in supporting equitable experiences in K-12 science. In the Virginia Demonstration Project (VDP), a workforce development project funded by the Office of Naval Research, the use of cooperative learning strategies was accompanied by positive student, teacher and administrator outcomes. At the end of their experience students reported they had made new friends with others who were "different", students with special needs were interacting with and contributing to their group's products, and first-generation Hispanic students were talking more with English-speaking classmates both in-class and informally. Teachers reported a shift from teacher-centered to student-centered instruction both in VDP lessons and in science lessons taught as part of the regular curriculum. Administrators considered heightened teacher comfort with the use of CL as a benefit of the project.

S3.4.12 Understanding How Students Solve Novel Design Challenges

Xornam Apedoe, University of San Francisco
Christian D. Schunn, University of Pittsburgh

Although research suggests that engaging students in design-based learning can be effective for learning science, more research is needed to understand how to most effectively facilitate this process for students. For those students who either struggle or are highly successful in this type of learning environment, what types of problem-solving strategies do they use to approach these design tasks? Understanding the ideas and strategies that students bring with them to the classroom environment has important implications for the design of curricula and classroom instructional practices. This study is a first step at exploring the problem solving strategies that students use, and the relationship of these problem-solving strategies to students' learning of science when engaged in design-based learning activities.

S3.4.13 Developmental Tasks, Stereotypes and Motivational Learning Environments in German Science Lessons

Nina Bertels, Freie Universität Berlin
Claus Bolte, Freie Universität Berlin

Developmental Tasks, Stereotypes and Motivational Learning Environments in German Science Lessons In Germany is a great demand for science specialists that, according to the Federal Ministry of Education and Research, three out of ten companies cannot meet their requirements. Despite these good prospects students are still unmotivated to learn science or to ask for a job in the science job market. How can one explain this phenomenon? We suppose that conventional science lessons (not only in Germany) don't help students to solve their developmental tasks (like vocational orientation is one), that in the students' view working in the field of chemistry is unattractive because of special stereotypes they had already constructed and because the learning environments are assessed by the students so unfortunately that they don't want to work (or learn) more in this area than they must, to get their final examinations. To find out, if this is "true", we conducted a survey to find out which developmental tasks are of importance from students' viewpoint and to what extent these developmental tasks are been taken up in chemistry lessons. Furthermore, we investigate the question of which chemistry-related prototypes the students have constructed and how these prejudices can be overcome, and last but not least to what extent chemistry classes which counteract stereotypes and take up questions of occupational orientation influence the student's motivation.

S3.4.14 Biotechnology Pedagogical Knowledge through Mortimer's Conceptual Profile

Andoni Garritz, Universidad Nacional Autonoma de Mexico
Patricia Velazquez, Universidad Nacional Autonoma de Mexico

Motivations for this research are to document and portray the pedagogical content knowledge (PCK) of a specific topic for high school education: biotechnology and to apply Mortimer's conceptual profile to characterize the teaching of this topic with emphasis in the epistemological strategies of teachers. PCK is documented for four teachers of high school and college levels by means of Loughran et al. methodology of Content Representation (CoRe) and Pedagogical and Professional Experience Repertoires (PaP-eRs). A conceptual profile set of graphs is elaborated by counting the number of phrases inside the CoRes belonging to one of four conceptual profile epistemological zones constructed by the researchers: perceptive/intuitive, contextual, empiricist and rationalist. Finally, the epistemological aptitudes of teachers are attained, characterized and discussed from the conceptual profile graphs.

S3.4.15 An Analysis of the Benefits Using different forms of Formative Assessment Strategies

Liling Chao, National Changhua University of Education
Jui Feng Wang, National Changhua University of Education
Wei Lung Wang, National Changhua University of Education
Chiung Fen Yen, Providence University, Taiwan
Fan Shing Chen, National Changhua University of Education
Tzu Hua Wang, Providence University, Taiwan

This study discusses the efficacy of high school students learning fundamental high school biology through e-learning environments and using different forms of online formative assessments. It utilizes the WATA system's Formative Assessment Module (FAM-WATA) to evaluate how requiring students to repeat responses a different number of times in order to pass affects their learning. Using quasi-experimental research methods, the study looks at five classes of tenth-grade students for a total of 207 people, split randomly into e-learning environments employing different formative assessment models. After three weeks of teaching, we discovered through ANCOVA analysis that the different formative assessments correlated with remarkable variations between their levels of learning efficacy ($p < 0.01$). The two groups required to respond twice or three times to pass, respectively, were compared with the group only required to mention topics once (the control group), and all displayed improvement ($p<0.01$), although there was no significance difference between having to respond correctly twice in a row to pass and having to respond correctly three times in a row to pass. What this shows is that high school student learning requires practice and the application of strategies, but that increasing the frequency of practice does not necessarily lead to increased learning benefits.

S3.4.16 Defining and Measuring Science Teachers' Conceptual Ecology for Assessment of Students' Learning in Science

Mehmet Aydeniz, The University of Tennessee, Knoxville
Lei Wang, Beijing Normal University

The authors developed a framework and a quantitative instrument for measuring science teachers' conceptual ecology for assessment of students' learning in science through the review of assessment literature in science education, educational measurement and the analysis of a qualitative set of data collected from secondary science teachers. The instrument was administered to 2962 Chinese secondary school science teachers. The results reveal that Chinese science teachers hold sophisticated conceptions of assessment when data is not aggregated by the years of teaching experience, the characteristics of their students population. Further analysis compare various factors that correlate with teachers' responses. Finally, we will compare the U.S. and Chinese secondary school science teachers' conceptual ecologies for the assessment of students' learning in science.

S3.4.17 Student Whiteboards: A Window on Thinking and Learning

Colleen Megowan-Romanowicz, Arizona State University

Modeling Physics Instruction is an inquiry-based approach to teaching science that relies heavily on small and whole group discourse around collaboratively prepared whiteboarded representations of laboratory findings and problem solving. This paper offers insights into what teachers who employ modeling instruction can learn about students' reasoning by carefully examining what they choose to represent on their whiteboards and by listening to the student discourse that surrounds the construction and sharing of these representations, and offers suggestions about managing classroom discourse to optimize thinking and learning in this environment.

S3.4.18 Differences in Reform-Based Classroom Practices of Novice Teachers in Block and Traditional Schedules

Allison L. Kirchhoff, University of Minnesota
Gillian Roehrig, University of Minnesota
Julie Luft, Arizona State University

While block scheduling advocates have claimed that it positively enhances reform-based, constructivist teaching (i.e. Canady & Rettig, 1993; Rettig & Canady, 2001; Keller, 1997), detractors have suggested that scheduling change alone will not result in changing the traditional beliefs and practices of teachers (Conley,1994; Cushman, 1995; Newmann, 1991). While much research has focused on how block scheduling relates to student achievement, much less research has been conducted on the main mediator influencing schedules and achievement: teacher classroom practices. In this comparative, qualitative study, we compared the classroom practices of traditional and block scheduled teachers who had been matched according to various demographic characteristics. ANOVA analyses were conducted initially, then the frequencies of classroom practices, organization and cognitive level of activities were compared to determine which group of teachers were more likely to engage their students in certain activities. Our findings suggest that block teachers engage their students more frequently in small groups, lab activities and knowledge representation and construction than traditional teachers. Traditional teachers favored lecture, receipt of knowledge and whole group or individual activities. This indicates that when contextualized analyses are undertaken regarding the relationship between scheduling and classroom practices, block scheduling seems to foster reform-based science teaching.

S3.4.19 Towards a Paradigm Shift in the Teacher's Role in Science Education – Teachers' Readiness for Change

Anne Laius, University of Tartu
Miia Rannikmäe, University of Tartu

This study was conducted about science teachers' readiness for change. It involved 12 voluntary science teachers, all of whom had completed a course on new trends in science, in which they gained extended knowledge in school science. The duration of the in-service intervention was 8 months and it based on the STL philosophy of promoting scientific literacy. The goals were: to find categories which describe science teachers' change as a result of different types of in-service intervention and to investigate teachers' readiness for fostering students' scientific creativity and reasoning skills. The sample consisted of 12 teachers, 8 teachers formed school teams, working in pairs, while four teachers participated as individuals. Data were collected via semi-structured interviews before and after the intervention and through an analysis of teacher created teaching materials. The data were analyzed, using a phenomenographical approach. The results revealed that four biggest changes in teachers' development were involved with philosophical and behavioral component: the way of starting the lesson in a more motivating way and using more frequently the group-work. The other biggest changes were concerned with moving towards teaching strategies that foster the students' skills of solving the problems and reasoning and their creative thinking.

S3.4.20 A Beginning Secondary Science Teacher who Works with English Language Learners: Looking at Instruction and Pedagogical Content Knowledge

Irasema Ortega, Arizona State University
Sissy Wong, Arizona State University
Jonah Firestone, Arizona State University
Julie Luft, Arizona State University

For the past decade, the public school system in the United States has experienced a steady increase in the number of English language learners (ELLs). Often ELL students are in schools that experience a high turnover of teachers. As a result, beginning teachers work with these students who have unique learning needs. This study examines the instructional materials and practice of one beginning science teacher who had the content background, the support of an electronic mentoring program and was enthusiastic to work with ELLs. The data consisted of lesson plans and instructional materials, observations of practice, as well as monthly and end of the year interviews collected over a three-year period. The analysis revealed that over the three-year period, the teacher experienced changes in pedagogical content knowledge (PCK) towards student-centered practices and utilized instructional materials that promoted language competencies and scientific inquiry amongst the students. The findings of this study indicate that with appropriate mentoring, a beginning science teacher who wanted to work with EELs was able to modify her instructional materials and classroom practices to better support the learning needs of her students. The findings of this study have implications for teacher induction and suggest that more research in this area should be conducted.

S3.5 Strand 5—Poster Session

S3.5.1 The Relationships between College Students' Epistemological Beliefs of Science and Conceptions of Learning Science

Jyh Chong Liang, Chin Min Institute of Technology
Chin Chung Tsai, National Taiwan University of Science and Technology
Min Hsien Lee, National Taiwan Normal University
Szu Hsien Wu, School of Medicine National Yang-Min

This study was conducted to explore the relationships between university students' epistemological beliefs and their conceptions of learning science. The participants in this study included 407 university students from 23 colleges or universities in Taiwan. All of the students had taken science-related courses. They were asked to respond to two questionnaires, that is, Epistemological Belief of Science scale (EBS) and Conceptions of Learning Science survey (COLS). The correlation results showed that students with less advanced epistemological beliefs in the dimensions of Source and Certainty. tended to have lower-level of conceptions of learning science such as Memorizing, Testing and Calculating and practicing. On the other hand, students with more sophisticated epistemological beliefs toward science in the dimensions of Development and Justification tended to express higher level of conceptions of learning science such as Increasing one's knowledge, Application and Understanding and seeing a new way. The regression analyses also supported the importance of EBS in predicting COLS, indicating that epistemological beliefs of science such as Source and Certainty are negative predictors of Memorizing, Testing and Calculating and practicing. The Development can be a positive predictor of Increasing one's knowledge and Understanding and see a new way of COLS.

S3.5.2 College Students' Domain-Specific Epistemological Beliefs of Sciences: A Comparison of Students' Conception of Biology and Physics

Wen-Yu Lee, National Taiwan University of Science and Technology
Chin-Chung Tsai, National Taiwan University of Science and Technology

This study is part of an investigation of interdisciplinary science training program. This study set off to provide a new framework and a viable technique for comparing between different science domains. Based on a within-subject design, we investigated students' epistemological beliefs in relation to biology and physics. Although previous studies suggested that domain-specific beliefs showed as early as the first year of college, but what remains unknown is whether any differences can be found between more closely related domains sciences. The proposed framework will contribute to both the research field of epistemological beliefs and the emerging research field of cross-disciplinary science education. In this study, we investigated three facets of students' epistemological beliefs: difficult of learning sciences, conception of sciences, and conception of scientific research. Eighteen college students with majors in different fields of science and applied sciences were interviewed individually. We presented in this proposal findings of 1) taxonomy and detailed description of domain-specific beliefs in biology and physics, 2) differences in students' epistemological beliefs by domain, and 3) differences in students' epistemological beliefs by students' majors. Findings from this study will also be the foundation of future design of a multi-domain questionnaire.

S3.5.3 Team Teaching of a Prep Course for Teaching Assistants

Gili Marbach-Ad, University of Maryland
Patty Shields, University of Maryland
Brett Kent, University of Maryland
Katerina V. Thompson, University of Maryland
William J. Higgins, University of Maryland

This study aimed to enhance the preparation of new Graduate Teaching Assistants (GTAs) for their teaching responsibilities. In our university, GTAs support faculty by leading laboratory sections, small group discussions, and study sections. While graduate programs typically provide extensive training in research, graduate students rarely receive any formal training for teaching. Smaller departmentally-based classes have previously been used to help prepare our GTAs, but inconsistencies across departments and graduate student disinterest left the instructors dissatisfied. In Fall 2007, we combined our three separate classes and developed one innovative and engaging teaching preparatory course for all new GTAs from our three Biological Sciences departments. It was team taught and all incoming GTAs were encouraged to take the class. We incorporated a variety of teaching approaches, including small group discussions and one-on-one instruction. The topics that were covered included: writing quizzes, grading using rubrics, academic dishonesty, effective time management, fostering meaningful class discussions, writing a comprehensive syllabus, and presentation skills. In the conference we will explain the course rationale, and provide feedback from a pre-post survey. Most GTAs reported that the course exceeded their expectations. The most valued course components were case study discussions with the faculty and the experienced GTA panel.

S3.5.4 Authentic Science Research Experiences for Undergraduates: Participation Patterns of Students Underrepresented in the Sciences

Troy D. Sadler, University of Florida
Luis Ponjuan, University of Florida
Lyle McKinney, University of Florida
Laura Waltrip, University of Florida

Programs designed to support undergraduate science research experiences (USRE) are a primary vehicle for increasing student interest and persistence in STEM fields, and several USRE programs have emerged to specifically support women and racial and ethnic minorities who remain underrepresented in STEM disciplines. The purpose of this study is to examine the experiences of underrepresented students in an early immersion USRE program. The research was guided by following question: What factors influence rates of participation in USRE between underrepresented students and their peers at a research extensive institution? We surveyed 59 diverse students following participation in a summer USRE program and applied multiple regression, using a hierarchical blocked regression model, to explore student self-reports of their experiences. The regression model explained 42% of the variance in frequency of participation in USRE activities, $F(8, 34) = 3.112$ (significant at $p<.01$). The results indicate that female students compared to male students are less likely to participate in research science lab activities. In contrast, racial/ethnic groups, students of color and Asian students, compared to White students were more likely to participate in research lab activities. Implications of these findings and relevance to science education contexts are discussed.

S3.5.5 Effects of Problem Based Learning on Students' Learning Satisfaction, Motivation, and Conceptual Change in a College Biology Course

Moon-Heum Cho, Indiana University - Purdue University
Deanna M. Lankford, University of Missouri
Daniel J. Wescott, University of Missouri

The purpose of this study was to investigate students' experiences with PBL in terms of learning satisfaction, motivation, and conceptual change. PBL was implemented in a large college science course. The empirical research results showed that students are less satisfied with PBL. After the PBL, students' self-efficacy was significantly decreased. However, interestingly, PBL was effective to promote students' conceptual change. In addition, this study demonstrated that PBL is more effective method than lecture based course to promote students' conceptual change. Discussions and implications for teaching and learning will be provided.

S3.5.6 The Complex Nature of Student Reading Questions in a Large-Lecture Biochemistry Course

Erika G. Offerdahl, North Dakota State University

Reading questions are student-generated questions about some aspect of an assigned reading from the course textbook. They are submitted electronically to the instructor prior to class. Other instructional strategies aimed at increasing student preparation prior to class such as reading quizzes are generally comprised of instructor-generated questions and are more teacher-centered. In contrast, reading questions do not restrict students to a predetermined set of topics and are more likely to provide a more detailed picture of students' thinking about a topic prior to instruction. The purpose of this study was to explore the nature of students' reading questions submitted throughout one semester of an undergraduate biochemistry course. Analysis of 194 reading questions revealed that students that students (1) pose two types of questions (topical and extension), (2) question at all levels of Bloom's taxonomy, with the majority at the application or analysis level, and (3) draw on three types of knowledge (principles, metaphors, and personal experience) when posing questions.

S3.5.7 Social Supports for Inquiry Learning with Virtual Laboratories: Evidence from Two Studies.

Eva Toth, Duquesne University

Social Supports for Inquiry Learning with Virtual Laboratories: Evidence from two studies. Inquiry learning has been a popular methodology in the college science classroom specifically with the safety and speed virtual laboratories offer for inquiry learning. With focus on the use of virtual laboratories for inquiry learning the paper examined the results of collaborative learning and the modes of collaborative discourse for the effective implementation of inquiry learning. Using evidence from two studies, the data indicates that while students benefit from collaborative learning the processes of knowledge building discourse are complex and should be carefully structured. The results provide support for the formulation of classroom pedagogies that employ collaborative knowledge construction. The significance of the currently on-going work is that it pays attention to both the process of information sharing as well as final form data of student thinking as part of an effective pedagogy. The methodologies and results described here are informative for NARST members who are planning innovation in their teaching by employing inquiry learning with virtual laboratories as an answer to the recent calls for the improvement of college student preparation in STEM fields.

S3.5.8 Using College Math Placement Exam Scores to Predict Achievement in Introductory Biology

Melissa Schen, Wright State University
Kathy Koenig, Wright State University
Christopher Schooley, Wright State University

There have been many studies identifying predictors for success in introductory biology. One common predictor is standardized math scores, although its relationship to introductory biology is somewhat surprising. This study looked at the ability of college math placement exams (MPL) to predict achievement in an introductory biology course, as compared to scientific reasoning skills measured by the Lawson Classroom Test of Scientific Reasoning (LCTSR). It was found that MPL scores correlated stronger and explained more variance in final letter grades than LCTSR scores. As the course focused on physiology concepts, it was hypothesized that the logical, sequential skills inherent in the algebra-based MPL exams would more greatly benefit a physiology-based course. Implications for college math prerequisites for introductory biology are discussed.

S3.5.9 Introduction to Inquiry and Traditional Curricula: The Implications of Content Differences in Preservice Middle School Science Students

Benjamin P. Heroux, University of Cincinnati
Catherine M. Koehler, University of Cincinnati
Jonathan Breiner, University of Cincinnati

The current investigation seeks to address the gap in research on the inquiry-content connection by answering the following question: what differences exist in the breadth and depth of content between the laboratory conclusions of middle school pre-service science teachers who participate in an inquiry-based lab situation and those that do not? Thirty preservice middle school science students engaged in a chemistry content course and associated laboratory. One section (the "control") received a laboratory curriculum similar to that used in previous years, consisting of a series of "cookbook" experiments with predetermined procedures. The other section ("experimental") received a laboratory curriculum informed by open-ended, inquiry-based instruction, where students developed their own procedures. This study employed a quasi-experimental design. Findings indicated that the experimental group demonstrated more breadth in their conclusions than the control group. Findings also indicated that the experimental group also demonstrated more depth of content understanding in their conclusions overall. The implications for teacher education suggest that students in this study who participated in an inquiry laboratory were learning chemistry content to a 6th-8th grade level and the control group understood the chemistry content at a lower grade level (1st-3rd grade). This is problematic at all levels of science education.

S3.6 Strand 6—Poster Session

S3.6.1 Multiple Perspectives of Out-of-School Learning in Various Institutions

Orly Morag, Technion
Tali Tal, Technion

Out-of-school educational activities are provided by a wide range of organizations such as environmental-organizations, zoos, museums and aquariums. Our aim was to study: how do school staffs choose and carry out field trips? how do coordinators of the various organizations view their relationships with schools? what are the challenges indicated by these coordinators? and what are the patterns of the educational activities? An Out-of-School Activity-Survey was administered to a random sample of school principals. Interviews were carried out with 17 education coordinators of 9 organizations; and 13 observation allowed identifying main patterns of activities; connection to the school curriculum and to the students' everyday experiences; teachers' and facilitators' function; and types of interactions between teachers, students and facilitators . We identified gaps between the way school-principals view their staff's involvement in out-of- school activities, and the way the organizations view the teachers' involvement. A common problem of the organizations was staff, which is not necessarily qualified for the job, and high turnover. The organizations' objective of preparing the students to (inter)national tests was surprising in the context of an environment that aims at increasing curiosity and passion for science. We identified good examples for activities conducted by some of the organizations.

S3.6.2 Shhh… Don'T Use the 'A' Word: Embedded Assessments of Youth Learning in Informal Learning Environments

Melissa Koch, SRI International
William R. Penuel, SRI International
Torie Gorges, SRI International
Geneva Haertel, SRI International

Finding appropriate ways of assessing learning outcomes of participants in informal learning environments is both a challenge and an important opportunity. The Build IT project addressed the challenge of assessing youth learning in a way that was consistent with the culture and goals of an informal learning environment. Build IT, a problem-based curriculum with performance tasks for IT fluency assessment, encourages middle school girls to develop IT fluency, interest in mathematics, and knowledge of IT careers. This study's focus on the process of design and enactment provides a window on how informal learning programs like Build IT can address the challenges of developing and implementing valid assessments of student learning that fit well in the informal learning environment and have sustainable use by practitioners.

S3.6.3 Blood, Sweat, and Gears: How the FIRST Robotics Competition Effects Attitudes toward Science

Anita G. Welch, North Dakota State University

With the increase need for effective programs to develop STEM literacy, this presentation reports on a study that examined the impact of participation in the FIRST Robotics Competition on high school students' attitude toward science using the seven attitudinal categories of the TOSRA survey. Data were collected using the Test of Science Related Attitudes (TORSA) pre- and post-survey. The results revealed that student participation in the FIRST Robotics Competition did provide statistically significant outcomes in four of the seven primary areas examined: Social Implication of Science, Normality of Scientists, Attitude to Scientific Inquiry, and Adoption of Scientific Attitudes. This study does offer evidence that the FIRST Robotics Competition has an attitudinal impact on students regarding views toward science. The uniqueness of this study is that it addresses the impact of FIRST Robotics on a variety of students. The findings of this study suggest that students participating in FIRST Robotics have more positive attitudes and interests in science than students not participating in the program. Their positive attitudes and interests may lead to higher academic achievement and future careers in science related fields, but more research will be needed to better understand the long term impact of the program.

S3.6.4 Silent Invasion: Investigating Oregonians' Self-Reported Awareness, Understanding and Behaviors toward Invasive Species

Lynn D. Dierking, Oregon State University
Samuel Chan, Oregon State University
Gwenn Kubeck, Oregon State University
Joseph Cone, Oregon State University

This paper describes research investigating Oregonians' awareness, understanding and behaviors toward invasive species prior to an educational intervention, which includes a public broadcasting program, Silent Invasion, focusing on invasive species, followed by a year-long public education and action campaign of written materials, a web site and opportunities to participate in action-oriented activities designed to alleviate the impacts of invasives. Two research approaches were utilized: a web-based and paper version of a statewide survey was administered and additional focus groups probing knowledge, attitudes and barriers towards invasive species were conducted with four (boaters, anglers, hunters and Master Gardeners) of six stakeholder groups surveyed (gardeners, boaters, anglers, hunters, general public and public broadcasting members). The survey sample was 1,000 (adjusted response rate of 23.8%) and 40 individuals participated in focus groups. Findings suggested that Oregonians are concerned about invasive species, have some understanding of the topic and are willing to learn more. However, despite this understanding, they perceive real barriers to tackling the issue and are looking for leadership from state and federal agencies and NGOs. Findings from this study were used to shape the public broadcasting program and its ancillary components. A follow-up study will assess the effectiveness of the effort.

S3.6.5 Comparing Out-of-School Research and Practice: Teachers' Field Trip Strategies on a Self-Guided Aquarium Visit

Bryan M. Rebar, Oregon State University

Field trips are well recognized as educational tools with the potential to complement and enhance classroom science teaching. Research over the past several decades has led to a broad understanding of field trip teaching strategies that, when employed, help take advantage of the unique learning opportunities afforded by field trips. Because many teachers lead their own field trips to institutions with educational missions such as aquariums, these teachers largely carry the responsibility of facilitating learning opportunities for their students. Although past research has included some descriptions of teachers' field trip leading strategies, there is a need for further detailed observation and analyses of these strategies particularly in the context of research-based recommendations. Which strategies are teachers actually using and how? In this study, twenty-six teachers were observed, surveyed, and a subset of teachers were interviewed in order to create rich descriptions of the strategies teachers are using and not using. Overall analyses reveal that teachers use a wide range of research-recommended strategies. However, the ways in which teachers employ these strategies suggest there are many ways teachers might enhance students' learning opportunities. This study, therefore, has implications for professional development leaders and educators striving to optimize learning on field trips.

S3.6.6 Implementing a Scientists in Schools Pilot Project: Issues and Outcomes

Leonie J. Rennie, Curtin University of Technology
Christine Howitt, Curtin University of Technology

Scientists in Schools (SiS) is a Government-funded initiative managed by the Commonwealth Scientific and Industrial Research Organization (CSIRO) for a pilot project during Semester 2, 2007. Through the establishment of sustained and ongoing partnerships between scientists and school communities, SiS aims to bring the practice of real world science to students and teachers, promoting science learning in schools, increasing scientists' engagement with the broader community, stimulating students' interest in science, and broadening their understanding of the variety of careers available in the sciences. Because SiS was a pilot project, its implementation was monitored, its outcomes measured, and some evidence- based recommendations developed regarding its potential continuation. Based on the outcomes of the evaluation, funding for SiS has been continued into 2009, however, the implementation of the pilot uncovered a number of lessons to be learned. In particular, the setting up of sustained partnerships, as distinct from single visits by scientists to schools, creates issues relating to flexibility and curriculum planning for both the managers and the prospective partners in such projects.

S3.6.7 Judging [at] a Science Fair: Dilemmas for Judges and Organizers

John L. Bencze, University of Toronto
Gervase M. Bowen, Mount Saint Vincent University
Nicole Arsenault, Mount Saint Vincent University

Students have been competing for awards at science fairs for many decades. Nevertheless, there is a relative paucity of published research in this area. To learn more about science fairs, we conducted a collaborative auto-ethnographic study of our roles as judges at Canada's national science fair. To do so, we analyzed — using constant comparative methods, based on constructivist grounded theory — our auto-ethnographic field notes, audio-recordings of conversations about judging, and copies of fair documentary material (e.g., judging forms). Findings highlight tensions regarding structures and traditions of the fair, on the one hand, and our perspectives about science, on the other hand. We particularly struggled with our perceptions that science was being presented as highly rational and isolated from fields of technology and societies. We also were left wondering how science fair organizers and science educators might respond to dilemmas we noted. Questions they might consider include: To what extent should science fairs focus on achievements of elite students? How should 'evaluation' (or, simply, analyses) of projects be arranged to more accurately reflect the nature of science? To what extent should fairs be publicly-funded, thus minimizing (or eliminating) private sponsorship?

S3.6.8 Timeline and Time Scale Cognition Experiments for a Geological Interpretative Exhibit at Grand Canyon

Steven Semken, Arizona State University
Jeff Dodick, The Hebrew University of Jerusalem, Israel
Orna Ben-David, The Hebrew University of Jerusalem, Israel
Monica Pineda, Arizona State University
Nievita Bueno Watts, Arizona State University
Cheryl Alvarado, Arizona State University
Karl Karlstrom, University of New Mexico

Linear timelines are analogical models that are frequently used in formal and informal learning settings to teach about geologic time; nonetheless, their effectiveness in such contexts has not been fully assessed. We examined respondents' abilities to understand and interpret a logarithmically scaled walking timeline: the Time Accelerator Trail (TAT). This is a prototype of a longer version that will soon be part of a major geoscience exhibit, "The Trail of Time," at Grand Canyon National Park. We asked 70 respondents to find precise points along our model timeline, each representing an event from recent times to 65 million years ago. We also tested their purely mathematical understanding of the timeline and its scale changes. Our results indicate that most Grand Canyon visitors should be able to understand the full-size TAT if each point on the timeline is clearly labeled, and if visitors are enabled to locate a few meaningful, contextualized events (e.g., one's own birth or a major historical event) along the timeline as they traverse it. Our findings have already informed modifications to TAT design, and the design of on-site cognitive experiments to be conducted on the permanent Trail of Time exhibition at Grand Canyon upon its completion.

S3.6.9 Using Novel Qualitative Methods for Studying Family Free-Choice Learning at Informal Astronomy Observing Events

Matthew Wenger, University of Arizona
Kathy Carter, University of Arizona
Christopher Harris, University of Arizona

We present a novel series of data collection methods to study family learning experiences at informal telescope observing events, commonly known as star parties. Participant families are paired with a "confederate family" whose members are covertly working with the researcher and tasked with initiating conversations with the participants. In addition to an interview that is conducted prior to the observing event, the two families are left alone for a short time in order to allow the confederate family to talk informally with the participants. During the event, the participants are audio and video recorded using a night-shot enabled camera. Afterwards, a final interview is conducted and the participant family is asked to generate a short video "blog" about their experience. In a follow-up interview at a later time, the participant family watches the video and thinks aloud in a stimulated recall procedure. We believe that the spontaneous talk between the participant and confederate families results in a more authentic representation of their experiences. In addition, the "shared experiences/ordeals" of family units allows participants to more freely voice their understandings and learning processes.

S3.6.10 Teaching Science in the City: Designing Pre-Service and In-Service Science Teacher Education

Maria S. Rivera Maulucci, Columbia University

The purpose of this paper is to describe and evaluate an innovative approach to in-service and pre-service science teacher development, the Science in the City seminar, that bridges formal and informal science learning contexts. While drawing upon the tenets of design and evaluation research, this study seeks to go beyond determining if the seminar is meeting program objectives to build a set of theories and practices that may guide the recruitment and retention of science majors into teaching, the preparation of elementary and middle-level teachers in science education, and the design of science professional development experiences for in-service teachers, particularly for urban schools.

S3.6.11 Science-Related Identity Development in Science Center Floor Staff

Jennifer D. Adams, Brooklyn College-CUNY
Preeti Gupta, New York Hall of Science

Science-rich informal learning institutions are a prime location for science teaching and learning. In addition, many of the institutions have out-of-school learning and work opportunities for students. This year-long study examines the experiences of high school students employed in an urban science center to serve as floor staff with the role of mediating experiences between the visitors and exhibits. We are concerned with how working in a teaching/facilitating role in an informal science-rich environment creates a science-related identity and impacts their experience with school and community science. Using cogenerative dialogues as a research methodology, we learned how developed and grew a praxis of floor facilitation and how this impacted their identities around science. Our findings suggest that working in teaching/leadership roles in informal science education settings enables youth to develop science-related identities. During this session we will elaborate on our findings and discuss the implications for out-of-classroom science learning and leadership experiences for youth.

S3.7 Strand 7—Poster Session

S3.7.1 Preservice Elementary Teachers' Ability to Learn How to Teaching Science from Instructional Materials: A Case Study of Japan

Etsuji Yamaguchi, University of Miyazaki, Japan
Shigenori Inagaki, Kobe University, Japan
Tomoyuki Nogami, Kobe University, Japan

Many of previous studies focused on the "current learning results" of science teachers. However, almost no studies have been made focusing on the theme "future learning potential." Currently, curriculum reforms are under way across the entire field of science education around the world. So, this theme would become even more important in future research on science teacher education. In this study, as the first step toward this theme, we conducted survey to clarify Japanese elementary teachers' ability to learn how to teaching science from instructional materials. Results are follows: (a) Prior to taking science education programs, it is possible for preservice teachers to learn the basic structure of Japan's elementary science lessons, under which teachers are required to convert what they want to teach into what their students want to learn, while enabling students to experience the process of scientific inquiry. (b) However, preservice teachers cannot learn teaching methods which both student- and science-oriented approach are well blended, has been well-received worldwide. (c) And also, preservice teachers can learn PK for elementary science lessons from the instructional materials, they tend to have difficulties in learning PCK. Finally, we discussed future research and requirement of science education program.

S3.7.2 Working in the Trenches: An Analysis of Induction and Post-Induction Science Teachers' Instructional Beliefs and Practices and the Links to their Pre-Service Preparation

John W. Tillotson, Syracuse University
Monica J. Young, Syracuse University
Paul Preczewski, Syracuse University
Robin L. Jones, Syracuse University

Teachers' beliefs are an important consideration in understanding classroom performance and in designing meaningful science teacher education programs. Researchers have concluded that while preservice program experiences can have a significant short-term impact on beginning teachers, more longitudinal studies are needed that investigate how new science teachers' beliefs and practices evolve with increasing classroom experience. The purpose of this longitudinal study was to compare and contrast the instructional beliefs and classroom practices of early-induction (n=60) and post-induction science teachers (n=36) who graduated from three distinct science teacher education programs participating in the NSF-sponsored IMPPACT Project. The Survey of Enacted Curriculum (SEC) was administered to participating teachers to gather detailed information on: 1) the demographic characteristics of their school and students; 2) their self-reported instructional practices and assessment strategies; 3) the factors that most influence their teaching beliefs and actions; 4) their perceptions of how well their preservice program prepared them for teaching; and 5) their beliefs about the external factors that shape their professional decision-making. Comparisons across experience levels and preservice programs will be discussed, as well as the implications for designing meaningful preservice and induction support programs.

S3.7.3 Examining Relationships between Expert and Pre-Service Teachers at a Summer Science Camp

Shehzad Bhojani, Mt. San Antonio College
Laura Henriques, California State University at Long Beach

Pairs of preservice teachers and experienced lead teachers work to plan and deliver 35 hours of science instruction during a summer science camp program at a large comprehensive urban university. Children grade 4 through high school attended the two week summer program after the teaching teams had already been working on campus for a week. Preservice teachers do most of the teaching with the lead teacher serving as a mentor. Not all mentors are created equal, neither are mentees! This qualitative study examined the relationships that emerged between mentors and mentees during the summer program. Attributes of effective mentors include empowering the novice and the ability to demonstrate and model reflective teaching practices. Effective mentors shared appropriate professional experiences but knew where to draw the line between their professional and personal lives. Effective mentors were able to differentiate the feedback they provided for their mentees. Mentees benefited from the partnership when they were open to constructive criticism, willing to work cooperatively, and able to admit that they did not already know everything. The nature of feedback provided by effective and non-effective mentors was also found to be significantly different.

S3.7.4 Preservice Science Teachers' Informal Reasoning Quality: An Analysis across Multiple Socioscientific Issues

Mustafa S Topcu, Yüzüncü Yýl University
Troy D. Sadler, University of Florida

The aim of this study was to explore Preservice Science Teachers' (PSTs) informal reasoning quality across multiple socioscientific issues (SSI). Constant comparative method (Glaser & Strauss, 1967) and seven SSI were used to explore PSTs' informal reasoning quality. Three SSI dealt with gene therapy and the other three issues dealt with cloning. The last issue dealt with global warming. Informal Reasoning Interview protocol was used to explore PSTs' informal reasoning quality. Totally, 39 PSTs voluntarily participated in the study. Senior elementary PSTs from a large public university, in city, a country were the intended sample for this study. Across each SSI, the participants easily developed claim with or without justification but they hardly developed counter-position and rebuttal. In other words, students developed less sophisticated informal reasoning quality instead of more sophisticated informal reasoning quality. Moreover, emergent frequency of informal reasoning quality types followed the same order across each SSI. In other words, approximately same pattern was observed with respect to the frequency of emergent informal reasoning quality. Thus, informal reasoning quality was not context-dependent across all SSI.

S3.7.5 Preservice Elementary Teachers' Diversity Beliefs: Influence of Science Methods Course on Personal and Professional Beliefs about Diversity

Adrienne Gifford, University of Minnesota
Bhaskar Upadhyay, University of Minnesota
Brian Fortney, University of Texas at Austin

This is a mixed method study. The study shows that elementary pre-service teachers' personal beliefs about diversity during science methods courses don't change but their professional beliefs about diversity do change. 56 preservice elementary teachers completed diversity beliefs survey (Pohan & Aguilar, 2001) and the data were analyzed using two-tailed t-test. In addition, the analysis of qualitative data from eight teachers showed that preservice elementary teachers held strong personal beliefs about diversity. Most of them resisted change despite their student teaching experiences in diverse elementary classroom settings. However, teachers' professional beliefs about diversity showed change, i.e. teachers became more aware and inclusive of students who came from non-White families. Elementary teachers believed that "personal and professional beliefs about diversity are … separate [entities]" because diversity accommodation as a teacher is job related and has nothing do with their personal beliefs.

S3.7.6 Into the Wild: Navigating a New Frontier for Pre-Service Science Teacher Education

Laura J. Saxman, The Center For Advanced Study in Education (CASE)
Preeti Gupta, The New York Hall of Science

The focus of this paper is a description of progress and data gathered to date regarding a National Science Foundation (NSF) funded pre-service training program for science teachers that represents a partnership between a formal university program and an informal science institution. In this project, undergraduate students who are enrolled in the required courses for secondary science education at a local College work as docents or Explainers at an urban, interactive science museum. Training experiences at the museum are structured so that students have the opportunity to practice and refine their teaching practice to a diverse audience in a variety of settings. Students are required to spend approximately 1000 hours at the museum site and receive training, feedback and mentoring from museum and project staff. The description of the project and findings provide important information about harnessing the potential of informal science centers as partners in the preparation of high quality science teachers. This information may serve to create awareness about an alternate approach to quality science teacher recruitment and preparation and in addition highlight aspects of the training model for replication.

S3.7.7 STEM Career-Changers in Their First Years of Teaching: A Follow-Up Study

Carol C. Johnston, Mount Saint Marys College
Jeanne M. Grier, California State University Channel Islands

Since the 1980s, recruitment of career change professionals has been viewed as having strong potential for easing shortages of qualified STEM area teachers. As science educators, many of us are involved in teacher preparation. As we emphasize the need for more quality science and math teachers, we need to develop a better understanding of how to help career changers transition to their positions within the teacher community. By better understanding the ways in which personal histories and previous career experiences influence teachers during their transitions into the classroom, we hope to learn how we can better support these teachers and, thus, affect the retention of STEM teachers, especially those in high-need schools. We ask the following research questions: What are the factors that influence career changers to stay in teaching or cause them to leave teaching? Do career changers' identities transform during their transition from STEM professional to experienced teacher? In this paper, we highlight three areas from our findings that relate to the intention to remain in teaching: preconceived ideas of teaching; support; and transitioning STEM/teacher identities.

S3.7.8 Enhancing Reform-Based Pre-Service Elementary Science Teaching Practices through Out-of-School Time Teaching

Tina J. Cartwright, Marshall University
Katie McDilda, Marshall University
Jennifer Jackson, Marshall University
Michael Corrigan, Marshall University

The potential connection and alignment between formal and informal learning is growing in interest across the country. In fact, the National Science Foundation recently funded, through the Academies for Young Scientists program, a group of projects to investigate this connection. One NSF-funded project, COMmunities Educating Tomorrow's Scientists (COMETS), is examining the potential for

utilizing pre-service teachers to facilitate after- school science investigations at community-based after-school programs. This study examines the reform-based constructivist science teaching practices of COMETS pre-service teachers as compared to pre-service teachers within an elementary science methods course. To assess reformed teaching practices, teachers were observed teaching a science lesson by a trained rater using the Reformed Teaching Observation Protocol (RTOP). Another pre- service teacher group was utilized from the author's university to serve as a comparison group. The RTOP scoring difference demonstrates the tendency for the COMETS instruction to be more reform-based. The subscale with the most significant difference (57.3% of the mean score improvement) was the Content in Procedural Knowledge which describes the student opportunity to explore phenomena in a variety of ways, to make and test predictions, to critically assess and actively engage in thought provoking activity.

S3.7.9 The Development and Utilization of a Standards-Based Instrument to Evaluate the Perceived Preparedness of Science and Mathematics Teachers in an Alternative Certification Program

William J. Boone, Miami University
Sandra K. Abell, University of Missouri
Mark J. Volkmann, University of Missouri
Fran Arbaugh, University of Missouri
John K. Lannin, University of Missouri

This poster will present details with regard to the development and utilization of a new Standards- based instrument. This instrument helps in the evaluation of students enrolled in an innovative science and mathematics alternative certification program. State standards and psychometric theory were utilized to help create the instrument which monitors students' perceived preparation. The instrument development process will be presented as well as the results of utilizing the instrument. Guidance for those interested in conceptualizing new instruments, and using the project's instrumentation will be provided at the poster session.

S3.7.10 Pre-Service Teachers' Synthetic View on Darwinism and Lamarckism

Minsu Ha, Korea National University of Education
Heeyoung Cha, Korea National University of Education

Two reasons why students have explained biological phenomena depending on Lamarckism based on the use and disuse hypothesis were inferred in this research. One was that students had connected Lamarckism with Darwinism after learning evolution. The other was that their understandings of evolution were based on their own empirical knowledge related to individual variation represented by the use and disuse. Our hypotheses were tested by analyzing the specially designed questionnaire to which thirty-nine university freshmen and sophomores as pre-service teachers were responded. Then ten of them were complied with the interview prepared to collect supplementary qualitative data. In the findings, they represented compound evolutionary explanations such as ¡®natural selection after the use and disuse'. On the qualitative data through interview, their Lamarckian views were connected with natural selection even more logically and strongly than a scientifically acceptable concept. As keeping on Lamarckian view, they had consistently considered on his/her own experiences related to individual modification by the use and disuse. Their compound logics of evolution let us suppose that the use and disuse hypothesis would be similar to p-prim (phenomenological primitive). This research demand constructivist teaching strategy to make the connection students' Lamarckian view with natural selection block.

S3.7.11 How Many Courses does it Take for Preservice Teachers to Understand the Essence of NOS and Inquiry? The Count is Ticking

Catherine M. Koehler, University of Cincinnati
Benjamin Heroux, University of Cincinnati
Jonathan Breiner, University of Cincinnati

Reform in science education has advocated that students need to understand inquiry and the nature of science [NOS] in order to be scientifically literate. The question remains as to the most optimal instructional approach to enhance science teaching and learning with regard to understanding NOS and inquiry so that teachers can translate this understanding to their students. This project addresses the research question: How many courses does it take for preservice teachers to understand the essence of NOS and inquiry and to teach it effectively in their classrooms? Twelve preservice middle school students took two quarters of chemistry during the F07 and W08 quarters. Two laboratories in F07 were taught using different pedagogical models (inquiry –experimental and cookbook-control). Students during the W08 enrolled one lab section that used a combination of the two pedagogies. Evolving notions of NOS and inquiry were investigated. Students in the experimental lab demonstrated slightly more informed views of NOS as measured by the VNOS. Similar results were noted in the inquiry arena using the ITB.

S3.7.12 Identifying and Meeting the Challenges of Developing Reform-Oriented Elementary Science Teachers

Moses K. Ochanji, California State University San Marcos
Thomas J. Diana, Utica College

This study sought to examine the impact of two elementary science methods courses on science teacher development. Drawing from various aspects of the two science methods courses and responses on the Science teacher beliefs Questionnaire, the study analyzed the development of preservice teachers' knowledge of science teaching, and how the various aspects of the methods courses influenced the development of this knowledge. Two cohorts of preservice teachers from two geographical regions participated in the study. The results of this study suggest a consistency in how preservice teachers think about using children's ideas to support student learning, making relevant connections between science topics and promoting conceptual change. At the same time, preservice teacher in these programs expect to gain more content from the courses in addition to the pedagogical dimension that is typical of science methods courses. Results indicate that Knowledge of Content and beliefs about content are a critical factor affecting the appropriation of conceptions and practices for teaching science. The results yielded from this study calls for further research investigations to be conducted on how to best implement professional development experiences during elementary teacher education programs that will have lasting impacts throughout teachers' careers.

S3.7.13 Teaching Preservice Teachers to Use Learning Theory to Make Instructional Decisions

Joanne K. Olson, Iowa State University
Michael P. Clough, Iowa State University
Crystal N. Bruxvoort, Calvin College
Andrea J. Vande Haar, University of Northern Iowa
Kimberly A. Penning, Iowa State University

Despite taking a course in educational psychology, prospective teachers struggle to see the relevance of this important knowledge base for decision-making in teaching. Previous work has found that prospective teachers can improve their decision-making practices to consider how children learn, both during their preservice years and 3-5 years later (Author, 2007; Madsen, 2005). This study assessed the effect, on preservice elementary teachers' understanding, of using instruction on key principles of learning theory coupled with increasingly difficult critical incidents that require the application of learning theory. Results indicate that these students improved their understanding and made more credible decisions about their science teaching, when compared to students who read practitioner-oriented articles related to learning theory and participated in whole-class discussion. This study has important implications for elementary science teacher preparation—analyzing video has been shown to improve learning theory understanding over traditional unit plans, but when coupled with the targeted readings and critical incidents, the prospective teachers are even better able to apply their understanding to unpredictable scenarios. Interestingly, all three groups (unit plan, video analysis, and video analysis + critical incidents) still diagnose classroom scenarios through the activity and student behavior/learning, but miss the crucial role of the teacher.

S3.7.14 Scientists to Teachers: The Role of Epistemology in Lesson Plans of Career Switchers

Erin E. Peters, George Mason University
Brad Rankin, George Mason University

Preparing pre-service teachers to teach scientific epistemologies, such as the nature of science, has been shown to be difficult. The participants in this multiple case study are former scientists who have from 5 to 30 years of experience in a laboratory setting who are now studying to become secondary science teachers. The purpose of this study was to examine how career switchers viewed student learning of scientific epistemologies and how they incorporated nature of science into their lesson plans as they participated in their first graduate level science methods class. After analyzing each case study separately, it was found that the career switchers' responses organized into two groups: schema-centered teachers and activity-centered teachers. The schema-centered teachers believed student epistemology was an integral component of teaching students science, and they approached lesson planning from the perspective of enduring understandings. Conversely, the activity- centered teachers expressed the need to show students what to think in science class. They created plans lesson by lesson, and then grouped the singular lessons in to a unit. Additionally, activity-centered teachers planned on only using the historical aspect of the nature of science because they felt the human interest stories would get students interested.

S3.8 Strand 8—Poster Session

S3.8.1 Science Teachers' Knowledge of the Water System

Younkyeong Nam, University of Minnesota
Fred Finley, University of Minnesota
Gillian Roehrig, University of Minnesota
Do earth science teachers really understand the Earth as a system? If so, how do they apply their earth systems knowledge in their lesson plans? This study assesses earth science teachers' knowledge of earth systems using an earth system framework developed by authors and explores how teachers select specific water system knowledge for teaching. The result provide two important factors; 1) science teachers have little awareness of the earth as a system and don't have enough knowledge for teaching water system; 2) there are many factors which can impact teachers' selection of water system knowledge for teaching. This study provides concrete evidence of how earth science teacher's knowledge about the water system can influence their instructional practice.

S3.8.2 Teacher-Student Interaction: The Overlooked Dimension of Inquiry-Based Professional Development

Alandeom W. Oliveira, University at Albany, SUNY

This study examines the types of social understandings or views that elementary teachers developed as a result of participating in a summer institute that sought to increase their awareness of the social or interactional aspects of classroom inquiry through a combination of expert instruction on classroom discourse (personal pronouns and hedges), inquiry immersion, collaborative discussions, and discourse analysis of videotaped inquiry science lessons. A grounded theory analysis of the institute professional development activities revealed that teachers became increasingly aware of the social functions of hedges and personal pronouns commonly used by instructors. More specifically, teachers demonstrated an increased awareness of the authoritative functions served by the exclusive we and I/you contrastive pairs, as well as the non-committal functions of hedges. Participants were able to recognize that hedges and personal pronouns serve important social functions (e.g., to avoid adopting an evaluative stance toward students' ideas and to build solidarity with students). Furthermore, it is argued that teachers need to be offered professional development opportunities that can enable them to become more effectively prepared to engage in inquiry-based teacher-student interactions.

S3.8.3 Impact of an Intensive Renewable Energy Course on the Science Self-Efficacy and Content Knowledge of K-8 Teachers

Margaret D. Nolan, Boston University
Donald DeRosa, Boston University
Andrew Duffy, Boston University
Russell Faux, Davis Square Research Associates
Peter Garik, Boston University
Bennett Goldberg, Boston University

The School of Education and the Departments of Mathematics and Physics at a major urban research university offer a graduate level course on renewable energy for K-8 teachers designed to improve their content knowledge in physical science concepts. It consists of five three-hour laboratory classes in the spring and a subsequent intensive immersion in the content material for two weeks in the summer. The objectives of this study were to evaluate the impact of the renewable energy course on participants' content knowledge, self-efficacy in teaching and understanding of the nature of science. Surveys on attitudes and beliefs, as well as content based tests, were administered at the outset and conclusion of the course. In addition to using standard surveys and concept evaluations, additional questions were presented to the students about their background and responses to the material of the course. Participants reported high self-efficacy regardless of low content knowledge at the outset of the course. After completion of the course, participants' content knowledge increased significantly while self-efficacy remained high. This leaves the question of resolving the inconsistency between the teachers' content knowledge and self-efficacy.

S3.8.4 Content Knowledge and Efficacy

Helene Sørensen, Århus University
Robert H. Evans, University of Copenhagen
Annemarie M Andersen, Århus University

International interest in the usefulness of self-efficacy and its association with science teaching has grown in the past twenty years. More recently, the importance which teaching environment has on self-efficacy has also begun to be more widely studied. However, while self-efficacy has long been accepted as a valid construct in many cultures, the large variability of local science teaching environments has yet to be established as having comparable affects on self-efficacy. This paper begins such a validation process by looking at some recent research in Australia, India, Taiwan and northern Europe and comparing it to original relationships established in the US. In a longitudinal study which measured self- efficacy and teaching environments among elementary teachers of science in the US and a northern European country, a significant correlation between these variables was found. This result adds to the international validity of context as a contributor to self-efficacy. The fact that teaching environment scores on both scales for both countries fall within similar ranges, suggests that the measurement of context in these two cultures is comparable. To a lesser extent, the same seems to be true in an Australian and Indian study.

S3.8.5 Supporting Senior High Science Data Logging Integration: the Identification and Support from Outsider Communities

Ronald J. MacDonald, University of Prince Edward Island
Angela F. Larter, University of Prince Edward Island
Jeff Carragher, Eastern School District
Chris Higginbotham, Western School Board
Lisa Ling, Eastern School District
Ryan McAleer, Western School Board
Dave Ramsay, Western School Board
Steven Wynne, Eastern School District

The most engaging type of student inquiry is authentic inquiry, where students generate the research question, control the variables, identify and control for bias, interpret and analyze the data. One resource that has shown promise to increase levels of student inquiry is the hand-held data logger (which can attach over 60 probes like motion sensors, pH meters). These devices, however, are most often used by teacher while students watch. Professional development may be to blame. Research suggests that Communities of Practice (CoPs) can help. Often, there are several pre-existing CoPs in the working lives of teachers, although they may not be identified as such. CoPs of 21 senior high science teachers from three schools from Prince Edward Island, Canada worked to integrated data loggers. This study investigates the interaction of the research-based CoP members with pre-existing teacher communities. Qualitative themes from interviews, focus groups and online postings suggest that it is essential to identify these pre-existing communities, as norms and practices from these other communities significantly affected the research CoP. This presentation will report on findings related to how these many CoPs worked together with a research-based CoP to synergize more effective integration of data logging technology in secondary science.

S3.8.6 School, Teacher, and Student Factors Impacting Students' Science Achievement

Debbie K. Jackson, Cleveland State University
Joanne E. Goodell, Cleveland State University
Sally Mascia, Cleveland Heights-University Heights City School District

In this paper, we report the results of a three level study using Hierarchical Linear Modeling (HLM) that investigated the achievement of urban 8th grade students on a state-administered achievement test in science. Results indicated that students' prior achievement, their participation in a higher-level course (Physical Science) and attendance were significant positive predictors of achievement. In addition, gender (female) was a significant negative predictor. Although the teacher level variables were not shown to be statistically significant the teachers completing the professional development were those teaching the higher level course; which was statistically significant. The strength of the school-based program and leadership stability also contributed to increased student achievement.

S3.8.7 Science Teachers and Scientific Argumentation: Trends in Practice and Beliefs

Victor Sampson, Florida State University

This qualitative study examines teachers understanding of scientific argumentation and their beliefs about the value of scientific argumentation as a way to promote student learning in the classroom. To explore these issues, thirty middle and secondary teachers were interviewed. As part of the interview, teachers were asked to evaluate alternative explanations, to generate written arguments, and to comment on their views about argumentation in science. A typological analysis of the teachers' comments and behaviors during the interview resulted in the identification of several trends. First, science teachers rely heavily on their content knowledge to evaluate the validity or acceptability alternative explanations rather than available data. Second, science teachers' understanding of what counts as a high quality argument in science does not reflect current or curriculum develop efforts. Science teachers, however, tend to report that they value argumentation as a way to improve the teaching and learning of science although they have a number of reservations about it.

Overall, this study provides a valuable empirical foundation that can be used by science teacher educators to guide the development of new learning experiences for pre-service or in-service science teachers.

S3.8.8 CASES: A Professional Development Experience for Enhancing Content and Supporting Inquiry-Based Science Teaching in Elementary Classrooms

Michelle L. Klosterman, University of Florida
Rose M. Pringle, University of Florida
Lynda Hayes, University of Florida
Katie Milton, University of Florida

Making the transition to science teaching, and more specifically, inquiry-based science instruction presents a challenge for most elementary teachers. This yearlong professional development involving the following features: collaboration, asynchronous collaboration, school structure, evaluation, and support (CASES), sought to increase elementary teachers' science content knowledge and inquiry-based pedagogical skills. It was conducted in two schools in north central Florida. The following questions guided our data collection: To what extent do participating teachers demonstrate increased understanding of science concepts targeted by the project? Can elementary teachers develop the understanding and skills needed to implement inquiry-based science pedagogy? Analysis of teacher performance on a science content knowledge exam, individual and group interviews, prolonged video-taping and classroom observations, and teacher-produced classroom artifacts indicated that the components of the professional development model successfully increased elementary teachers' science content knowledge and their ability to use inquiry-based science instruction. Administrative support proved essential to the model's success and the teachers' confidence in their ability to teach science. Because of its comprehensive manner, CASES was responsive to the needs of the participants as they learned science content knowledge and developed inquiry-based pedagogy within a collaborative learning community throughout the school year.

S3.8.9 Exploring Written Discourse in e-Mentoring: When a First-Year Science Teacher at a Charter School Met an Expert Mentor in a Virtual World

EunJin Bang, Iowa State University
Julie Luft, Arizona State University

This study illustrates the dialogical aspect of an online mentoring program through written discourses between Penelope, a first-year science teacher, and Cathy, an expert science teacher. The analysis revealed that a majority of posts were related to logistics of the school system and teaching. As a result, Penelope was able to solve many of her first-time school experiences by receiving rich personalized stories from the Cathy. Also, construction of knowledge was evident between them when tensions and teamwork were created. From these results, we suggest that e-mentoring programs are one of the effective dialogical tools for disseminating knowledge of experts and for expediting the professional growth of new science teachers.

S3.8.10 What Can Scientists Do? Assessing K-12 Science Teachers' Educational Product Needs

Stephanie J. Slater, University of Wyoming
Timothy F. Slater, University of Wyoming

Much of the last two decades of education reform calls students to have authentic science inquiry experiences that mimic scientific research using real scientific data. In order for professional planetary scientists to provide the most useful data and professional development for K-12 teachers in support of science education reform, an extensive, national survey of nearly 800 "alpha teachers" was undertaken to determine how teachers are currently using planetary science data and, if not, why not. Although teachers had considerable awareness of online data resources, few report frequent use of online data for authentic inquiry and analysis in the classroom. Teachers' primary use of the Internet for data is to download images to share with students. Only one-quarter of teachers report that they ever use any online data in the form of large WWW data sets, real data, or virtual data to engage students in inquiry or data analysis and virtually no teachers reported using data- sets delivered on CD-ROMS. These results suggest that the most influential role for the community of scientists is to support professional development on a limited number of existing data products rather than creating or expanding new products and to focus PD on implementation rather than creation.

S3.8.11 Zones of Influence: Creating Professional Development Opportunities for Instructors of Informal Science Education

Rashmi Kumar, University of Pennsylvania
Susan Yoon, University of Pennsylvania
Melissa Chessler, Independent Consultant

Informal science education (ISE) opportunities are created both by schools and institutions like zoos, aquariums, and nature centers. Both groups of ISE providers are seen as important venues through which young people gain access to complex ideas in science through playful and creative activities, and hands-on projects. Within another ongoing science project that provides a diverse population of urban youth innovative ways to experience learning in science, the researchers have observed that collaborative practices among in-school (IST) and out-of school (OST) instructors result into remarkable changes in the teaching practices and programmatic details of the latter. The study hypothesizes that in contrast to IST instructors who acquire access to new pedagogical methods through numerous in-service opportunities (Fishman & Krajcik, 2003; Frazer-Abder et al., 2006) OST instructors do not have access to comparable training opportunities that prepare them to construct pedagogically sound teaching programs and teach diverse student populations. The study presents findings from several sources including profiles of constituents, participant surveys and interviews, and photographic and anecdotal (but insightful) documentation.

S3.9 Strand 9—Poster Session

S3.9.1 Classroom Action Research as Professional Development in Science Education

Margilee P. Hilson, Columbus City Schools, Ohio
Kathy Cabe Trundle, The Ohio State University
Donna Farland-Smith, The Ohio State University

This study investigated links between student achievement gains as measured by standardized test scores and voluntary teacher participation in science classroom action research projects. Data from three school years were combined for this investigation. Twenty-eight cases were high school teachers, 12 cases were middle school teachers and 27 cases were elementary teachers for a total sample of 67 cases. Multiple data sources were analyzed in the descriptive and interpretive analysis of the data. Effect size results indicated that elementary projects had an effect size of .76, middle school projects had an effect size of.82, and high school projects had an effect size of .24. Teacher learning centered on pedagogical and PCK. Interpretive document analysis of teacher research summary reports, school district professional development records, and program guideline documents revealed three areas of teaching practice linked to student achievement. The first area involved variations in the overall research focus implemented by the teachers. The second area concerned teacher identification of research questions. The third area, linking teaching practice to high student achievement, was the selection of instructional strategy. Successful teaching practices incorporated from other professional development episodes included literacy strategies, use of data to inform instruction, and facilitating active student engagement.

S3.9.2 Subject-Related Mentoring in Biology Teacher Education

Doris Elster, University of Kiel

GIMMS is a Comenius 2.1 project on science teacher education founded by the European Commission. It started in October 2006 for a period of three years. The main goal is the improvement of science teacher education in European countries. Six partners from European universities, educational institutions and schools in Ireland, Denmark, Germany, Spain, Austria and the Czech Republic are registered for participation. The GIMMS project will link curriculum reform and teacher education through piloting a number of mentoring models and through the identification, development and dissemination of innovative gender proofed practices in mathematics and science teaching. At NARST we will present first results of a mentoring process within a practical course in biology teacher education (Germany and Austria). Teacher students and mentors of university and schools develop together gender sensitive materials ("Lara is pregnant") and test them in the classroom. The process is documented with reflective journals and photographs. The view of pupils, students and mentors are juxtaposed.

S3.9.3 Pre-Service Elementary Teachers, Date-Related Science Practices, and Socioscientific Issues

Nicole Beeman-Cadwallader, Indiana University
Gayle A. Buck, Indiana University

The purpose of this self-study was to understand how using socioscientific issues (SSI) as a context to explore data interpretation would transform pre-service elementary science teachers': a) enactment of data-related science practices, b) perceptions of data interpretation and analysis, and c) attitudes towards data interpretation and analysis. Data sources included: pre-service teachers' written work, video- and audio-recordings of course experiences, and instructional artifacts. Five themes emerged from direct interpretation and categorical aggregation. These themes included: 1) using a context of socioscientific issues (SSI) increased pre-service teachers' beliefs about the importance of data interpretation and analysis, 2) only some pre-service teachers' expressed a strong position on SSI after the unit, 3) after the unit, pre-service teachers indicated they felt more comfortable with data interpretation and analysis, 4) pre-service teachers' perceptions of their understanding often did not match what their work demonstrated, and 5) pre-service teachers only enacted some data-related science practices suggested by reform documents. The conclusion of this study was that using SSI as a context for pre-service elementary teachers' enactment of data-related science practices had mixed results, but potential. Implications for using class debriefings and scaffolded argumentation to realize the potential of using SSI will be discussed.

S3.9.4 Using an Action Research Framework to Broaden Teacher Candidates' Views of Critical Multicultural Science Education: Insights and Challenges

Azza Sharkawy

Critical multicultural science and technology education (CMSTE) emphasizes facilitating in students the knowledge, skills and commitment to contribute to the development of a more socially and environmentally sound society (Hodson, 1999). While the goals and assumptions underpinning CMSTE have been theoretically supported by many science education researchers, there is little empirical work in this area (Krugly-Smolska, 1999). The purpose of this qualitative study was to explore developments in elementary teacher candidates' conceptions of CMSTE (e.g., who it is for, what it means, why it is important) within the context of an elementary science methods course supported by action research. The implications of the findings for research and teacher education practice will be discussed.

S3.9.5 Secondary Science Teachers' Collaborative Reflections on Sharing Best Practices

Connie F.C. Woytowich, University at Albany

This phenomenological intervention study with a reflective component utilizes the shared practice and reflection model, which is based on the introduction phase of the collaborative apprenticeship model (Glazer and Hannafin, 2006). Six high school biology teachers participated in this study. The reflective component of the model reveals a myriad of benefits and barriers to sharing best practices, and teachers' views on the process. The author argues that teachers need to become leaders in their professional development, and that barriers to collaborative reflection and sharing best practices cannot be overcome without guidance and support from school leadership and policymakers.

S3.10 Strand 10—Poster Session

S3.10.1 The Development of Argumentation Skills and Content Knowledge of Intermolecular Forces Using a Nanoscience Context

Harold B. Short, University of Michigan
Morten Lundsgaard, University of Michigan
Joseph Krajcik, University of Michigan

Intermolecular forces are an important explanatory paradigm in high school chemistry and are prerequisites for understanding many nanoscale phenomena. However, students struggle to develop normative ideas about this topic. Since new advances in nanoscience offer interesting and motivating contexts, we designed a curriculum focusing on the nanoscale phenomenon of how geckos defy gravity and cling to ceilings in order to contextualize content on intermolecular forces. By structuring the unit as a series of investigations to determine which of several mechanisms explains gecko adhesion, we were also able to develop skills in scientific argumentation. As students learned about potential adhesion mechanisms through inquiry, they utilized their new understanding to evaluate these mechanisms and craft arguments supporting their positions. To describe the development of student content knowledge in concert with argumentation ability, we administered pre/post tests, conducted pre/post interviews, and collected written artifacts. Results indicate significant growth in content knowledge on electrostatic charge, London dispersion forces, and comparisons between different intermolecular interactions. Performance in argumentation was more nuanced with students able to form claims and use evidence, but struggling to provide reasoning. Our work offers insights to those seeking to develop problem-based instruction that combines challenging content with practice in argumentation.

S3.10.2 The Interaction of Assessment Format and Sex in Assessing Knowledge Structure Coherence for the Understanding of Force Concepts

Sharon P. Schleigh, East Carolina University

The Interaction of Assessment Format and Sex in Assessing Knowledge Structure Coherence for the Understanding of Force Concepts ABSTRACT This study focuses on the impact of assessment format on the identification of students' ideas surrounding the concept of force and the consistency with which students apply those ideas across contexts, in response to the debate in conceptual change literature regarding students' knowledge structure coherence. It examines the potential of a constructed- response-assessment format as another possible instrument for data collection involving larger sample populations, exploring the biases and interactions of sex, order, preference and format of 45 middle school aged students. Overall the differences between the assessment formats were found to be insignificant, suggesting that the constructed-response could be administered on a larger scale to assist in the identification of factors contributing to the differences in the previous studies.

S3.10.3 Wallpaper or Instructional Aids: A Preliminary Case Study of Science Teachers' Perceptions and Use of Wall-Posters in the Classroom

Michael Hubenthal, IRIS Consortium

Education and outreach efforts associated with science and research organizations regularly utilize wall-posters as a convenient method to communicate scientific concepts to students, teachers, and the general public. Are these posters just "wallpaper" for classrooms, "advertising" for the science organization and its field of research, or, do posters have some value in the educational process? This preliminary issue-focused case study finds that science teachers value these wall-posters and use a spectrum of strategies to enhance both the educational setting and instructional process. At the simplest level, teachers use posters to enhance the aesthetics of the physical space by reducing sterility and contributing a "sciencey" look and feel to the classroom. At more complex level, posters provide visual introductions to content and stimulate student interest. Teachers' examination of sample posters, representative of other posters produced by the science community, suggests a conflict between poster producers' construction as stand alone communicators of content and teachers desire for posters to support their own communication of content in the classroom. While this study provides insights into teachers' perceptions and use of wall posters, the preliminary nature of this study leaves many broad lines of questioning for further exploration.

S3.10.4 Research and Development of an Educative Teachers' Guide for Explicit Nature of Science Curriculum Materials

Shu-Fen Lin, National Chiao Tung University
Sang-Chong Lieu, National Hualien University of Education
Wen-Hua Chang, National Taiwan Normal University
Wen-Ling Chen, De-Gau Elementary School
Sufen Chen, National Taiwan University of Science and Technology
Mao-Tsai Huang, National Academy of Educational Research

This paper reports an innovative way of researching and developing an educative teachers' guide for explicit Nature of Science (NOS) curriculum materials (CMs). This study was based on the research and development of explicit NOS curriculums, and professional development program for inquiry and NOS instruction. The framework and layout of the teachers' guide was mainly based on the survey of assistance of teachers' guides for science teachers (Lin, Chang, Cheng, & Hsu, 2008) to meet Taiwanese science teachers' need and assistance. The content of the teachers' guide was examined by the criteria of educative CMs developed by Beyer, Delgado, Davis, and Krajcik (2007) and new criteria for NOS-PCK to support science teacher learning. In this article, we will present how we develop the teachers' guide for explicit NOS CMs and show the characteristics of the teachers' guide to support teachers teaching NOS explicitly.

S3.10.5 Towards the Use of Concept Maps in Large-Scale Science Assessments: Exploring the Efficiency of Two Scoring Methods

Maria Araceli Ruiz-Primo, University of Colorado Denver
Heidi Iverson, University of Colorado at Boulder
Yue Yin, University of Illinois, Chicago

The current emphasis on public school accountability has focused attention on large-scale assessments and altered the characteristics they have. The National Assessment Governing Board's decision to include concept maps in the 2009 National Assessment of Educational Progress (NAEP) Science Framework reflects one of these changes. The possibility of including concept maps in the 2009 NAEP Science exam is especially promising for tapping student science achievement where connected understanding and knowledge structure. However, there are some technical issues that still need to be considered before concept maps are used in large-scale contexts; one of them is scoring. For concept maps to be used as large-scale assessment, a scoring system that is both efficient and effective in providing reliable and valid score interpretations is needed. The purpose of this study is to provide information about the validity of the score interpretations of two concept map scoring methods. Scoring Method 1 considers all the propositions students' provide in their concept maps and Scoring Method 2 considers only critical propositions based on the importance of the concepts involved in the relationships. More specifically, we asked: Are student scores based on the total number of propositions exchangeable with scores based only on critical propositions?

S3.10.6 Problem Solving Competencies in Chemistry

Rüdiger Tiemann, Humboldt-University at Berlin
Jenny Koppelt, Humboldt-University at Berlin

Many countries developed national educational standards (e.g. USA, Great Britain and Australia) in response to problems in their (science) education (see e.g. Carter, 2005). These standards describe educational goals and define competencies, which students have to achieve until a certain form. Although reforms are executed in the field of education policy internationally, only little research concerning to these reforms has been realized so far (Lemke, 2001). To analyze the required competencies, for example, appropriate competency models are needed. But formulated and empirically ensured competency models only exist for single fields and age groups. So far, models describing levels are often gained post hoc. Up to now theoretical derivatives are rare. For this reason the aim of the presented project is the development and the empirical examination of a competency model for problem solving in chemistry. The developed model describes the problem solving ability in chemistry contents in particular, specifies the single steps of the problem solving process and is characterized by three levels. Therefore it has a share in national educational standards. For evaluating the model, a computer based instrument, based on the model, has been developed. The investigation is carried out from May 2006 till May 2009 with 451 students at the age of 15. Using a partial credit model, the data analysis will be completed. The competence model and the results of the study will be presented at the conference.

S3.10.7 Examination of Science Process Skills in New Elementary Science and Technology Curriculum

Jale Cakiroglu, Middle East Technical University
Sevgi Aydin, Middle East Technical University

Science Process Skills (SPS) are one of the important parts of science education and therefore they should be included in science curriculums. The purpose of the study was to examine the distribution of SPS through grades 4 to 8 in a recently developed science and technology curriculum based on constructivism. For that purpose, objectives in the curriculum were examined. Furthermore, percentages of SPSs through grades and figures showing the overall distribution of them were given. Results showed that there was not a homogeneous distribution of SPS through the science curriculum. Moreover, there was a gradual decrease in Basic Science Process Skills (BSPS) through grades 4 to 8 whereas there was a steady increase in Integrated Science process Skills (ISPS) from grades 4 to 8.

S3.10.8 Pathways to Inquiry - Earth Science: Online Tools to Strengthen Classroom Understanding and Integration of Science Inquiry Skills

Pamela B. Blanchard, Louisiana State University
Yiping Lou, Louisiana State University

The NSF Teacher Professional Continuum Proof-of-Concept Project, Pathways to Inquiry (PTI): Earth Science, is creating two interrelated Internet-based tools to help professional developers and classroom teachers assess science process skills in the context of earth science. The Inquiry Skill Analyzer (iSA) is a short online assessment to help teachers (and students) to: 1) identify strengths and weaknesses in their understanding of science process skills in the context of earth science, and 2) track their progress in these process skills as they strive to improve their expertise over a period of time. Once an inquiry skill area has been identified, teachers can go to the Inquiry Activity Portal (iAP) to find an online lesson that has been keyed to both earth science topics and specific inquiry skills they wish to develop. The iAP contains a matrix of newly developed and/or adapted online lessons in which the specific inquiry skills utilized by the students have been identified. Each online lesson is accompanied by an "inquiry overlay" clearly identifying the inquiry skills used in the lessons, as well as an overview of the pedagogical strategies used, additional worksheets to support any adjustments to the activity, other supporting resources, and assessment ideas.

S3.10.9 Hypothetical Learning Trajectory for Measurement: A Multidisciplinary Study

Jennifer Schiller, State University of New York at Buffalo
Nosisi Feza, State University of New York at Buffalo
Joseph Johnson, State University of New York at Buffalo
Julie Sarama, State University of New York at Buffalo
Douglas H. Clements, State University of New York at Buffalo
Jeffrey Barrett, Illinois State University

This proposed poster presentation would be the first report from the recently-funded NSF project to establish developmental progressions of measurement--clear cognitive accounts of the development of students' strategic and conceptual knowledge of measure. Such developmental progressions constitute infrastructures for improving assessment tools, instructional strategies, curricular materials and professional development models (Smith et al., 2006, pp. 2-4). Documenting students' developing knowledge of and strategies for measurement constitutes a multi-faceted research agenda requiring multiple perspectives (ours include those of mathematics, science, cognitive science, and constructivism). Initial findings indicate that these multiple perspectives along with specific teaching methods, including whole class and individual teacher experiments around life science, led to a stronger foundational and life applicable understanding of length and volume measurement.

S3.10.10 Science Teachers' Perceptions about New Science and Technology Curriculum

Sevgi Kingir, Selcuk University

This study aims to understand the perceptions of elementary science teachers about new Turkish science and technology curriculum. Three female science teachers participated in this study. The interview process was used to collect phenomenological data. In order to analyze the data, firstly the data was transcribed, and then the codes and themes were generated. Four themes emerged from the data: feelings about curriculum, comparison of new and old curriculum, intent of curriculum, and strengths of curriculum The results showed that teachers' attitudes toward the curriculum were positive. All the participants criticized the number of objectives and units. Only the first participant criticized the arrangement of units, the appropriateness of units for grade levels, the distribution of units throughout grade level in biology, and lack of spiral approach among the science disciplines. This study showed that being a novice or experienced teacher is not influential on teachers' perceptions about new science and technology curriculum. Teachers' endeavor to develop them is very influential in having a thorough understanding of the curriculum. In conclusion, the teachers working in public schools held superficial views about new curriculum, but the teacher working in private school held deep views about new curriculum.

S3.10.11 Curriculum Revision: Exploring Teachers' Views and their Affective Factors on New Science Curriculum

Yi-Ting Cheng, National Changhua University of Education
Wen-Yu Chang, National Changhua University of Education
Huey-Por Chang, National Changhua University of Education
Jun-Yi Chen, National Chiayi University

The purpose of this study was to conduct a pilot testing program and explore its influence on curriculum revision in Taiwan. This study also explored the views of junior high schools' science teachers and the affective factors about the development of a new textbook. Further, the teachers' attitudes toward participating in pilot testing program were investigated. Thirteen science teachers from three junior high schools located in northern, middle, and southern Taiwan participated in this project. The research period lasted for 3 years. Taking field-notes, videotaping meetings, interviews, and answering questionnaires were followed to investigate teachers' perceptions. The results revealed that teachers tended to pay more attention to the sentences, pictures, and the amount of the content. However, whether the new textbook could fit the students' capability, learning motivation and promote their learning and thinking were rarely noticed. The factors affected teachers' views of the textbook included their teaching schedules, students' scores on the exam, and their previous teaching experiences. Results of this study also indicated teachers' attitude toward participated in the program were changed. In summary, this study could provide not only teachers' views of a new version of textbook, but also a referent for future development of science curriculum.

S3.11 Strand 11—Poster Session

S3.11.1 Teaching Science to Immigrant Students with Culturally-Sensitive Pedagogy: Empowering Language Minority Students

Bhaskar Upadhyay, University of Minnesota

This study explores how Jody, a White female teacher, enacts culturally-sensitive pedagogy to teach science to empower students from an immigrant group. I further emphasize specific aspects of Jody's curriculum and pedagogy, as well as evidence of her reflectiveness while teaching science. I use the theoretical frameworks of funds of knowledge, empowerment, and culturally-sensitive pedagogy.

S3.11.2 A 7-12 Urban Science Fair: Patterns of Participation and Category Selection by Age and Gender

Kathleen A. Fadigan, Penn State University

Dating back to the late 1920's science fairs have been highly popular venues in science education, but very little research has been conducted regarding the participants and any potential benefits. This exploratory study provides a preliminary profile of the participants in a large urban science fair. The research explores the demographics of 450 participants with a focus on age group, gender, and category selection. Results show that there are a significantly greater number of middle school students and a greater number of girls entering this competition. At each grade level grouping females constitute an increasing percentage of entries. Gender patterns of category selection also reveal expected areas of underrepresentation for girls (physics and engineering) and boys (behavioral and social science).

S3.11.3 Cultural Food Days and Growing Gardens?: Pre-Service Elementary Teacher Emerging Beliefs and Knowledge about Contextualizing Science Instruction for Diversity and Social Justice

Sara E. Tolbert, University of California, Santa Cruz

This paper describes the results from a study that investigates pre-service elementary teacher beliefs and knowledge about contextualizing science instruction for culturally and linguistically diverse learners. Data was collected from a diverse sample of 100 pre-service elementary teachers' responses to an open-ended survey question regarding diversity and science teaching, as well as from semi-structured in-depth interviews with 18 pre-service elementary teachers. Two analytical tools were developed to code both teacher beliefs and knowledge about contextualizing science instruction to the sociopolitical, cultural, and linguistic backgrounds of students in elementary science classrooms. Results demonstrate that most pre-service teachers are oriented toward teaching science for diversity, but display limited knowledge of contextualized science instruction. The challenge is for teacher educators to provide extensive opportunities for pre-service teachers to participate in contextualized activities and instruction, which differ dramatically from the traditional science education.

S3.11.4 Establishing Access to Science through the Back Door: What are Elementary Teachers' Perspectives on the Integration of English Language Development and Science instruction?

Susan Gomez-Zwiep, CSU Long Beach
William J. Straits, CSU Long Beach

This study investigates one school district's attempt to provide equitable access to science instruction for the large number of English Language Learners (ELLs) it serves. This attempt involves the blending of English Language Development (ELD) and Science instruction at four elementary schools. This blending will go beyond the traditional scaffolding of content and instruction for ELLs but will require science to be the context for all ELD instruction. This study investigates how the elementary teachers at these sites envision this overlap and their feelings and beliefs towards this goal? Teachers were placed in small groups and asked to record instructional elements that are essential to 1) science instruction, 2) ELD instruction, and 3) which of these elements if any overlap between both domains. Written responses were coded and analyzed for frequency and placement. In addition, personal reflections were collected as well. The findings of this study indicate that not only are elementary teachers capable of envisioning this new approach but they are anxious to begin planning its implementation. In addition, teachers often described this approach as a new opportunity to engage students in higher-ordered thinking skills despite their English language level.

S3.11.5 Using Curriculum to Close Achievement Gaps

Susan M. Kowalski, BSCS Center for Curriculum Development
Molly A. M. Stuhlsatz, BSCS Center for Research and Evaluation
Joseph A. Taylor, BSCS Center for Research and Evaluation

Women and minorities do not participate in the science and engineering workforce at rates consistent with their populations in the U.S. (Rosser, 2000). A variety of theoretical frameworks and associated interventions have been cited in the literature, yet the gender and racial gaps remain (Clewell & Campbell, 2002). Johnson, Kahle, and Fargo (2007) found that effective teaching may be instrumental to eliminating achievement gaps in science. Taylor, Van Scotter, and Coulson (2007) found that teacher fidelity to cohesive, coherent curricula correlates to teacher effectiveness. This study uses hierarchical regression to examine whether teacher use of research-based, cohesive, coherent curricula can prevent the emergence or expansion of achievement gaps by socio-economic status, race/ethnicity, or gender. Students'(N = 390) free/reduced-price lunch status, race/ethnicity, and gender did not account for variation in posttest scores once pretest score and math level had been taken into account. We examine the research-based strategies used in the curriculum that may account for the "no gaps" result.

S3.11.6 Cultural Diversity in the Classroom: Salish Kootenai Students' Perceptions of Ecosystem Relationships

Rose E. Honey, Harvard University
Tina A. Grotzer, Harvard University

There are increasingly diverse cultures co-existing inside of classrooms. Culture can shape beliefs about how the world works including ideas about causality and the cognitive processes we use to reason about what we know. This study considers how students' experiences and cultural backgrounds may interact with and influence the assumptions they make about the world around them. We hope to begin laying the groundwork towards understanding obstacles and affordances to learning for children from diverse cultures in science classrooms today. Our exploration investigated how Salish Kootenai students talk about food webs, plant decomposition, and experiences outside of school related to these ideas. How these students talk about ecosystem relationships as compared to earlier research on student interpretations of causal connections within ecosystems begins to reveal how cultures may value and emphasize certain patterns of perception, and how this may influence learning. Our findings show that the Salish Kootenai students had less difficulty tracing indirect effects on animal populations in food web systems, were more likely to mention how plant decay may relate to new plant growth, and revealed a familiarity with the balance and flux in ecosystems due to personal experiences such as how hunting may influence nature.

S3.11.7 Educator Impacts on the Self-Efficacy Beliefs of Women in Chemistry: A Case Study

Megan L. Grunert, Purdue University
George M. Bodner, Purdue University

This study identified the factors and experiences that contribute to the development of women's self-efficacy beliefs in chemistry; how women's self-efficacy beliefs contribute to their education and career decisions; and how women's self-efficacy beliefs in science and chemistry change over time. This was accomplished through an evaluation of the self-efficacy beliefs of female chemistry graduate and undergraduate students. Data collection included a self-efficacy survey and three in-depth interviews with the participants. The data were used to construct narratives of each of the participants, which were then analyzed to understand each participant's experience in chemistry, as well as to identify commonalities among and differences between participants. These emergent threads were correlated with the theoretical sources that contribute to the development and modification of self-efficacy beliefs. Results of a case-study analysis of one participant showed the impact of educators on self-efficacy beliefs. An approachable, caring demeanor positively shaped efficacy beliefs while intimidating, distant professors hindered the development of positive efficacy beliefs. Additionally, attitude towards failure or poor performance has an effect on whether students re-take a course or drop out of the program. These findings have implications for educators' classroom demeanor and interactions with students.

S3.11.8 Fictive Kinship as it Affects Resiliency and Perseverance of Inner-City High School Students in a College Physics Lab

Konstantinos Alexakos, Brooklyn College, CUNY
Jayson K. Jones

This critical ethnographic study examines how fictive kinship (close personal friendship) amongst a group of three inner-city high school students affected their work during a challenging experiment in a college physics class they were attending. Through video analysis and

conversations with these three participants as well as with their class as a whole, it is found that their close personal ties greatly facilitated high perseverance and resiliency within the group through support and motivation of each other.

S3.11.9 Charting the Pipeline: Identifying the Critical Life Elements in the Development of Successful African American Scientists, Engineers, and Mathematicians

Brian A. Williams, Georgia State University

The purpose of this study was to identify critical life elements in the development of successful African American scientists, engineers, and mathematicians. Specifically, the study was designed to answer the following questions as they pertained to African American graduate students: What factors were perceived to have contributed to the students' initial interest in science, engineering, or mathematics? What factors were perceived to have contributed to the students' decisions to continue their studies in their specific areas of interest? What factors, associated with the K-12 schooling experience, were perceived to have contributed to the students' success in science, engineering, or mathematics? Qualitative interviews with 32 African American graduate students in science, engineering, and mathematics (SEM) served as the study's data source. Four major themes emerged from the analysis of the data: all students (1) had a significant level of participation in SEM, (2) experienced positive personal intervention by another person, (3) related their involvement in SEM to positive outcomes, and (4) believed they possessed intrinsic qualities that predisposed them for success in SEM. In addition to the individual themes, the data also yielded a developmental model for describing the phenomenon. Significance for the research, policy, and practice is discussed.

S3.11.10 Prospective STEM Teachers' Assumptions about Low Income or Poor Students and their Families

Athena R. Ganchorre, University of Arizona
Debra Tomanek, University of Arizona

This study investigated motivations among prospective teachers at a Southwest research one university who commit to teaching secondary level science or mathematics in under-resourced districts. An interpretive method uncovered assumptions prospective STEM teachers have about low income or poor students and their families. These assumptions included (1) low income or poor students' linguistic, cultural and socioeconomic backgrounds present challenges to learning that place them at an academic disadvantage, (2) to achieve academic success in high needs schools takes the collective will and resources of the community, its families, students, teachers and administrators. Despite an understanding of the challenges to learning opportunities high need students' face we believe there is strong evidence that prospective STEM teachers believe the reasons for poor academic performance lies primarily within low income or poor students and families. Prospective STEM teachers believe (3) low income or poor families do not demonstrate values and behaviors that promote academic achievement and (4) low income or poor students are likely to engage in activities counter-productive for learning and achievement than students from more affluent backgrounds. An implication of the study is the knowledge that it can contribute to efforts targeting the preparation of STEM teachers for under-resourced schools.

S3.11.11 Gender Issues in Science Education: Beyond Gaps to Strategies for Action

Patricia K. Freitag, Education Consulting

Diversifying the workforce in science, technology, engineering, and mathematics (STEM) fields as well as STEM education requires that we step up our efforts to make the sciences more inviting and supportive for women and particularly for women of color. The National Science Foundation's Gender Research in Science and Engineering Program (NSF-GSE) supports research, diffusion, and extension service projects that address equity, science teaching and learning, and career trajectories in STEM fields and STEM education. In this paper the results of an NSF funded exploratory research study to develop a program level logic model and characterize the broader impacts of the Research on Gender in Science and Engineering Program are presented. Principal investigator interviews provide qualitative input for the further development of the NSF-GSE program logic model. Measures of broader impact for the program are identified. Implications for taking action to close gaps between males and females in STEM education and STEM fields will be discussed.

S3.11.12 Examining Adolescent Girls' Engagement in Problem-Based Science Instruction

Gayle Buck, Indiana University
Nicole Beeman-Cadwallader, Indiana University
Amy Trauth-Nare, Indiana University

Recent science educational reform projects for adolescents have attempted to engage students in science by utilizing problem-based instruction. The features of Problem-Based Science (PBS) are consistent with the learning needs of many types of learners and, overall, the approach holds promise for meeting the needs of diverse learners. Although this approach has proven to have great potential, particularly in urban settings, questions remain unexplored in regards to the learning experiences of specific populations of learners. This study was part of a larger effort to increase the level of engagement in science by diverse populations of students. The purpose of this particular study was to provide a descriptive, as well as interpretive, account of girls' engagement in a PBS instructional unit. This feminist case study was guided by the questions, "In what ways did the girls engage in the PBS unit?", "What type of instruction within the PBS unit fostered desired levels of engagement?", and "What type of instruction within the PBS unit fostered undesirable levels of engagement?"

S3.11.13 A Case Study on a Socio-Scientific Curriculum Facilitating Undergraduates NOS Conceptualizations

Kelly A. Schalk, University of Maryland

This study reports the effects of an innovative introductory microbiology course for undergraduates, which emphasized a socio-scientific issues (SSI)-based curriculum. The SSI initiative describes teaching science through social issues with conceptual or technological ties to science. Microbiology is an excellent SSI forum as it relates to many popular science "Grand Challenges and Great Opportunities" areas such as genetics, health/disease, diet/nutrition, and our environment. This SSI framework gave undergraduates opportunities to research popular science issues and design experiments. The significance of this investigation was that it addressed a gap in the literature, namely what is known about SSI treatments on college-aged students. Specifically, this study investigated the effects a SSI-based curriculum had on undergraduates' Nature of Science (NOS) conceptualizations. It was found that undergraduates epistemological views about science matured, which influenced their informal reasoning. In particular, students' reasoning changed as they realized 1) the difference between facts, theories, opinions, and conclusions; 2) that testable questions are not definitively proven; 3) there is no stepwise procedure scientists follow during experiments; and 4) lack of data is a weakness in a claim. Consequently, this investigation suggests a SSI-based curriculum can enhance college-aged students' understanding of science knowledge to make more informed decisions.

S3.11.14 There Must Be: Differences between Estonian and Russian Students'

Imbi Henno, Tallinn University
Priit Reiska, Tallinn University

Abstract: This study focused on Estonian students and examined their science achievement in PISA 2006. Estonia was one the highest-performing country on the PISA 2006 science scale. But there was a significant difference in the average scores for ethnically different students in all three main PISA domains (science, mathematics and reading). The purpose of this study was to examine the differences of ethnically Estonian students` and Russian students` in concern about self-efficacy and self-concept in science and performance on the science scale. Besides small gender differences in the statistical results, no significant reciprocal relationship have been found between science achievement and self-efficacy among students of two language instruction schools. There was the statistically significant difference between genders and ethnics groups in self-concept in science in Estonia. The students of Estonian language instruction school reported lower level of self-concept in science.

S3.11.15 Facilitating Science Understanding and Fluency among Hispanic ELL Students: Strategies, Explorations, and New Directions

Ann Cavallo, The University of Texas at Arlington
Patricia Gomez, The University of Texas at Arlington

This paper focuses on how education may be structured to meet the linguistic needs of Hispanic ELL's in learning science. In doing so, this paper addresses teacher change that is necessary for our schools to meet the challenges of a diverse and global society, as well as the challenges of preparing all students for STEM careers that our society so greatly needs. To support and add new knowledge to current understandings of science learning among Hispanic ELL students, the paper presents research conducted on fourth grade Hispanic ELL students' understandings of Nature of Science (NOS), their abilities to understand and use science processes, self-efficacy, interest, and views of science and scientists. The results of this study are used to reveal and inform educators of practices found most effective in the science teaching and learning of Hispanic ELL students.

S3.11.16 The Practice of Science Inquiry within a Small Group of Hmong Youth

Michele J Hollingsworth Koomen, Gustavus Adolphus College

This paper/poster reports on an interpretive study of three Hmong youth in a seventh grade urban middle school science classroom. Critical theory, science for all, the notion of funds of knowledge and lived experiences collectively informed the research data collection with analysis using grounded theory. Analyzing the collective narratives illuminate a practice of science that is different for each of the three Hmong youth: A practice of science that is tied with the language of science (William) and teeters tentatively on the expertise and interactions that he has within his small group; a practice of science that is dutiful and pragmatic (Mai) although absent in passion or curiosity, and a practice of science that closely matches a vision of science by the national reform documents (David). Implications of this study to the greater research community are included.

S3.11.17 The Influence of Departmental Climate on Female Engineering Professors

Monica J. Young, Syracuse University
John W. Tillotson, Syracuse University

This qualitative study investigated and compared the perceptions of male and female engineering professors concerning the departmental and institutional climate within their respective university engineering programs. This study examined key variables along the STEM continuum that contribute to the gender gap among engineering faculty members through comparative case studies of female and male mechanical engineering professors from eight universities across the United States. The intent was to determine the commonalities and differences that exist within and between these two groups to gain additional insight into the problem of underrepresentation of women in STEM fields. The data suggest that male and female faculty members agree that the tenure process is essentially the same for all faculty members, but many male faculty members neglected to consider the unique challenges associated with childbirth and extension of the tenure clock that many women face. Female faculty members expressed greater difficulty establishing research collaborations, but all faculty members realized the potential for a more positive departmental climate as more female faculty members are hired.

S3.11.18 Korean Elementary School Students' Views about Nature: An Interpretive Worldview Study

Jeongae Won, Daejeon Meabong Elementary School, Korea
Seonghey Paik, Korea National University of Education, Korea
William W. Cobern, Western Michigan University

In this study, Korean elementary school students' views about nature were investigated. The participants were 18 fifth and sixth grade students. Data were collected via semi-structured interviews involving a set of elicitation devices used to encourage students who discussed their views about nature. The analysis of interview transcripts yielded inferences about student fundamental beliefs based on a logico-structural worldview theory. We found several characteristics of students' views about nature. First, students had diverse views about nature. Second, most of students represent their ontological views that imply influence of the Korean traditional culture view about nature. Third, after each of students experience same natural phenomena or natural things, they express different understanding, feeling and thinking about them. Forth, we found that school science education had an effect on students' views about. Finally, most of students have a view that comes from school science experiences and a view that comes from personal experiences. It was noteworthy that students felt no conflict at all the between two difference views. The findings showed that Korean science educators or teachers should be interested in their students' various views about nature, because it might be helpful to understand very well students as learners.

S3.12 Strand 12—Poster Session

S3.12.1 Learning the Effects of Drug Abuse on the Brain by Virtual Exhibit and Video Games in Museum

Meng-Tzu Cheng, NC State University
Leonard Annetta, NC State University
Elizabeth Folta, NC State University

The 'Virtual Brain' project, sponsored by the National Institute of Health, was designed to employ a 3D exhibit and video games as a fun and engaging way to convey knowledge and concepts about neuroscience, and the effects of drug abuse on the brain in an informal educational setting. The proposal was purposed to run an evaluation of this exhibit that promises to teach participants from various age, ethnicity, and gender backgrounds the impact of methamphetamines on the brain. Two-sample paired t-test, MANOVA and subsequent ANOVAs were performed to exam the difference between pre- and post-test and to determine if there was a difference by age, gender, ethnicity, and race. Five significant findings were reported: (1) There was a significance between pre- and post- knowledge tasks (t =

-21.60, $p < .01$); (2) The gain score was significantly different between adults and children ($F=3.32$, $p < .05$); (3) Participants showed an improvement on attitudes toward methamphetamine use ($t = -5.77$, $p < .01$); (4) Sensation seeking ability is not a good predictor on participants' performance ($r = .026$); and (5) Participants had an overall positive affection toward the Virtual Brain exhibit (4.18 ± 0.83).

S3.12.2 Examining How Teachers Use Web 2.0 Technologies in Science Lessons to Promote Higher Order Thinking Skills

Gail D. Chittleborough, Deakin University Victoria, Australia
Wendy Jobling, Deakin University Victoria, Australia
Filocha M. Haslam, Deakin University Victoria, Australia
Peter Hubber, Deakin University Victoria, Australia
Gerard Calnin, Association of Independent Schools Victoria, Australia

During 2007 several independent Victorian secondary schools participated in a study exploring the ways in which the use of learning technologies can support the development of higher order thinking skills for students. This paper focuses on the use of Information and Communications Technologies (ICT) including Web 2.0 technologies for promoting effective teaching and learning in science. A case study methodology was used to describe how individual teachers used ICT and Web 2.0 in their settings. Data included interviews (focus group and individual), questionnaires, monitoring of teacher and student use of smart tools, analysis of curriculum documents and delivery methods and of student work samples. The evaluation used an interpretive methodology to investigate five research areas: Higher-order thinking, Metacognitive awareness, Team work/collaboration, Affect towards school/learning and Ownership of learning. Two cases are reported on in this paper. Both describe how student engagement and learning increased and how teachers attitudes and skills developed. Examples of student and teacher blogs are provided to illustrate how such technologies encourage students and teachers to look beyond text science.

S3.12.3 Technology Use and Students' Perceptions in Science and Art Courses: Has there been Any Change Lately?

Rana M. Tamim, Concordia University
Gretchen Lowwerison, Concordia University
Richard F. Schmid, Concordia University
Robert M. Bernard

The purpose of this research is to investigate the change, if any, which had occurred during the past four years in the relationship between perceived course effectiveness and a variety of factors including technology use in both science and art courses. A 71-item questionnaire (based on the 14 APA Learner-Centered Principles) addressing students' learning experience in a specific course was used. The instrument has been validated through factor analysis to have a three-factor structure (course-structure, active-learning and time-on-task, and computer-use). Participants were students at a Canadian university (2003=1805 participants with 598 being in science courses, 2007= 1866 participants with 341 being in science courses). Results indicated higher technology-use in 2007 for all applications with art courses while only web-based computer applications increased in frequency of use with the science courses. Regression analysis showed the three are predictive of perceived course effectiveness with the arts courses but only course-structure was predictive of the outcome measure in the science courses. Implications are discussed and suggestions for future research are presented.

S3.12.4 Growth in Teacher Self-Efficacy through Participation in a High-Tech Instructional Design Community

Colleen Megowan-Romanowicz, Arizona State University
Sibel Uysal, Arizona State University
David A. Birchfield, Arizona State University

The Situated Multimedia Arts Learning Laboratory (SMALLab) is a semi-immersive mixed reality learning environment that affords face-to-face interaction by co-located participants within a 3-dimensional space informed by visual and sonic media that respond to participants' movements and gestures within the space. Over the past year, SMALLab has been field-tested in high school science classes in a large public high school in the southwestern United States. A team of high school science teachers and university researchers have met weekly in a professional learning community to design learning scenarios and a framework for student participation. This paper describes changes in teachers' self-efficacy as they become encultured in a cutting edge instructional technology design community.

S3.12.5 Gender-Related Beliefs of Turkish Female Science Teachers and Their Effect on Their Interactions with Female and Male Students

Sibel Uysal, Arizona State University
Eric Margolis, Arizona State University

The purpose of this study is to examine the relationship between Turkish female science teachers' gender-related beliefs and those teachers' corresponding treatment of their male and female students. The data was generated from three different sources: surveys, interviews, and observations. The data was analyzed using the Ericson interpretive method of socio-cultural theories which provided a framework for understanding the development of teacher attitudes, beliefs, and interactions with their students in the classroom. In this study, traditional and modern Turkish teachers had different gender-related beliefs regarding the role of women in science and women in society. Traditional teachers believed that their male students were brighter than their female students in science and they expected their male students to be more successful than their female students. Modern teachers did not behave any differently toward either their male or female students. Based on classroom observations, it was discovered that traditional and modern teachers interacted differently with their male and female students. Traditional teachers interacted more frequently with their male students, whether positively or negatively, than they did with their female students. Modern teachers, by comparison, did not pay any more attention or interacted more frequently with their students based on their gender.

S3.12.6 Teaching Science Methods Online: Addressing the Online Paradigm and Considerations for Optimizing Online Instruction

Charles B. Hutchison, University of North Carolina at Charlotte

On-line instruction has become a near-conventional part of teaching and learning. However, the art of teaching face-to-face—a different instructional paradigm—is still the yardstick for measuring the effectiveness of on-line instruction. This paper uses heuristic case studies to address some of the issues inherent in the planning and teaching of science methods exclusively on-line. It also raises new issues for considerations in on-line teaching, including the need to distinguish between content equivalence and experiential equivalence. Considerations for optimizing online course management and content delivery issues are also discussed.

S3.12.7 Challenges using Multimedia Integrated within a Science Curriculum using a Classroom-Centered Design Approach

Rebecca R. Deutscher, UC Berkeley

The purpose of this study was to evaluate multimedia that is integrated within a middle school science curriculum. The goal of the project was to make the multimedia work better for students and teachers in the classroom. This evaluation used a classroom-centered design approach that focuses on the whole school context. The curriculum that was evaluated was Full Option Science System (FOSS), a hands-on, inquiry-based science curriculum. Two groups of participants took an online survey: 539 middle school teachers and 22 trainers. The teachers were asked about their backgrounds, the technology at their schools, and their impressions of the FOSS multimedia. The trainers answered questions about their background as a trainer, and their experiences with the multimedia during trainings. As a result, one discovered many challenges and issues connected with using the multimedia. These challenges included the technical issues, location of computers, best way to present the multimedia, and training. By examining the challenges, developers can improve professional development, teacher manuals, and multimedia associated with science curriculum to make it more useful for teachers, administrators, and other educators. The impact on the students will be a much richer and more positive learning experience using multimedia to enhance their science skills.

S3.12.8 Students' Perceptions of Online Learning Environments

Michelle Cook, Clemson University
Leonard A. Annetta, North Carolina State University
Daniel L. Dickerson, Old Dominion University
James Minogue, North Carolina State University

This research investigated three different forms of computer-mediated communication. In this study, students were assigned to synchronous voice chat, synchronous text chat, and asynchronous discussion board groups. Perceptions of the quality of the online learning environment were compared among the three groups.

S3.12.9 Impact of Othello Game through E-Learning on Fifth Graders' Creativity and Problem-Solving Abilities

Wanchu Huang, Taipei Municipal University of Education
Wen-Hsien Lin, SinPu Elementary School

This study was to investigate the impacts on fifth graders' creativity and problem-solving abilities by implementing Othello game through e-Learning. The main design was quantitative, which was supplemented by the qualitative data. The research design undertaken was the experiment (E1, E2) and control (C1, C2) groups' pretest-posttest design, and the quantitative data were analyzed by one-way ANCOVA. Research instruments included Williams Creative Assessment Packet (CAP), Scientific Creativity Examination (SCE), and Test of Non-verbal Intelligence, 2nd ed. (TONI-2). Qualitative data were mainly collected from semi structured interviews. The e-learning was held in the computer class with Windows XP operating system and WZebra freeware. Each Lesson took 40 minutes and lasted for eight weeks. The findings were: (1) experiment groups were significant higher than control groups on total scores of SCE and TONI-2 posttest, but there were individual differences on different aspects of creativity among pupils. (2) The medium and low rating groups were capable of using Othello basic strategies, while the high group tended to use some complicated strategies with holistic game monitoring ability after Othello instruction. The conclusion of this study was "Learning through Othello game may promote pupils' creativity and problem-solving abilities."

S3.12.10 Learning Secondary Science Using Geospatial Technology: Understanding Student Experiences and Perceptions

Clare K. Morgan, Hobart and William Smith Colleges
James G. MaKinster, Hobart and William Smith Colleges
Nancy M. Trautmann, Cornell University

GT Science (pseudonym) is a three year professional development project focused on enabling secondary teachers to teach science using geospatial technology and helping students see the academic and career potential of these tools. Previous studies of GT- Science focused on teacher experiences, the iterative design of the project, and a quantitative assessment of student perceptions. This study provides an in-depth look at experiences and perceptions of students from three GT-Science classrooms. Through classroom observations, student interviews, teacher interviews, and student surveys, the authors examine how student experiences and perceptions of geospatial technology lessons in science classes differ among these classrooms. Results suggest that using geospatial technologies to learn science can build on the prior technological experiences of students, enable students to learn through multiple learning modalities, and reveal a wide range of students' perceived spatial abilities.

S3.12.11 Using Simulations to Support Powerful Formative Assessments of Complex Science Learning

Edys Quellmalz, WestEd
Barbara C. Buckley, WestEd
Mike Timms, WestEd

Frequent formative assessments improve student performance, but there is scant information about the features and quality of these assessments (Black & Wiliam, 1998, Herman, et.al, 2005). Moreover, the technical quality of assessments developed by teachers or those embedded in published curriculum materials is often questionable (Wilson & Sloan, 2000). Simulation-based assessments hold promise for supporting formative assessments of rich science learning. Simulations enable students to actively conduct investigations using models of complex scientific phenomena and thus demonstrate integrated knowledge and inquiry skills that are otherwise difficult to test (Authors, 2005). The simulation-based assessments present engaging interactive tasks testing complex science knowledge and inquiry skills for middle school science topics. They serve formative purposes by providing immediate feedback and coaching contingent on a student's performance, and by supporting additional instruction. Employing principles of evidence-centered assessment design (Mislevy et al., 2002), we developed assessments that capture a student's actions when interacting with simulations such as friction and force, food webs, and population dynamics and provide feedback and coaching driven by student response actions. The assessments undergo an iterative cycle of review, and feasibility testing via cognitive interviews. We present findings from feasibility testing of these assessments.

S3.13 Strand 13—Poster Session

S3.13.1 Metacognitive Underpinnings of "Nature of Science" and Implications for Science Education

Nicola Mittelsten Scheid, Queens University, Canada
Peter Chin, Queens University, Canada
Metacognitive underpinnings of "nature of science" and implications for science education Scientific activities such as reasoning require not only performance at a cognitive level but also metacognitive thinking about both the nature of knowledge and knowing strategies, that is, epistemological understanding (EPU) and metastrategic knowledge (MSK). It follows that it is a crucial objective to integrate metacognition into theories and models of science education. In order to contribute to this objective, the analytic argument of this conceptual paper demonstrates that EPU and MSK underly scientific activities and contribute to an adequate understanding of nature of science (NOS) as a core issue of science education, that NOS has primarily been defined epistemologically but that MSK has to be and can be elaborated within NOS. Moreover, we present developmental levels of metacognitive knowledge which may serve as a basis for metacognition-driven teaching and learning processes and, finally, we outline how traditional and recent teaching models can be meta-cognitively transformed. Thus, the analytic argument promotes a thorough understanding of NOS within science education, fosters the quality of scientific activities and science education by a metacognitive approach, and contributes to necessary adaptations of teaching and learning processes.

S3.13.2 The Context, Accuracy and Frequency of Inclusion of Key Nature of Science Concepts in Current Secondary Level Physics Textbooks

Saeed Alsamrani, University of Arkansas
William F. McComas, University of Arkansas

The seven most frequently used U.S. secondary physics texts were analyzed with respect to a master list of twelve key nature-of-science concepts (K-NOS) derived from a literature review of expert suggestions. The review noted the frequency of appearance, the placement (context) of these concepts, and the accuracy with which these key concepts were portrayed. The report discusses the production of the K-NOS list, the development of the coding guide (with exemplars) and details conclusions related to the research goals. Overall, there were 585 separate inclusions from the K-NOS list found in the seven books with the frequency for individual texts extending from 41 to 174 inclusions, with an overall accuracy of 96%. The vast majority (85%) of NOS inclusions appeared in the main text rather than in the glossary or in table/figure descriptions. Each K-NOS item appears at least once but the distinction between observation and inference did not appear at all. Subjectivity in science, the interplay of science and society and the distinction between science and technology are other items with very low rates of appearance. The notion that science is tentative appeared more than 100 times overall, with half of these appearances in the same text.

S3.13.3 The Nature of the Pedagogy of the History of Science

Catherine Lange, State University of New York College at Buffalo
Josephy Zawicki, State University of New York College at Buffalo
Barbara Rascoe, Mercer University

Science educators have dedicated a significant amount of energy to the promotion of inquiry- based instructional strategies that advance students' higher level thinking skills. The National Science Education Standards mandate an emphasis on the history of science and historical perspectives, yet science teachers have a paucity of knowledge about the history of science and typically lack the ability to contextualize science as a human endeavor. Critical, as well as higher level thinking skills in science also require students to develop an appreciation for how we know what we know in science—the nature of science. Inclusion of the history of science in science learning and environments can have many positive results in student performance, such as: (a) increasing comprehension of scientific methods and concepts; (b) enhancing understanding of the evolution of scientific theories; (c) promoting the intrinsic value of how science is done; (d) counteracting scientism and dogmatism that are sometimes found in textbooks and in science teachers' scientific paradigms; (d) humanizing science; and (e) connecting science to other disciplines. This research effort will examine strategies specific to historic based science pedagogy that underscore relationships among human activities, the development of scientific thinking, and philosophical issues in science.

S3.13.4 Reliabilism: An Epistemological Framework for Defining Knowledge in the Science Classroom

Samuel R. ODell, Jr., University of Georgia

According to a 2001 review (Southerland et al, 2001), a wide variation existed in the use of the constructs "knowledge" and "belief," indicating a general state of confusion and lack of consensus regarding their treatment within science education. A reading of recent science education journals demonstrates that there is clearly still no consensus position in science education that differentiates between knowledge and belief. This lack of consensus becomes particularly problematic when considering the widely-publicized assault on evolution education by creation/intelligent design advocates. This presentation will attempt to address this issue by delineating a particular branch of epistemology, reliabilism, discussing its applicability to science, and arguing for its use in differentiating between what is knowledge and belief in the science classroom.

S3.13.5 Supporting Preservice Elementary Teachers' Nature of Science Instruction

Valarie L. Akerson, Indiana University
Lisa A. Donnelly, Kent State University
Morgan Riggs, Indiana University
Jennifer Eastwood, Indiana University

This study explored the influence a community of learners had on preservice elementary teachers' nature of science (NOS) teaching. Using a combination of focus group discussions, five preservice teachers met with university personnel bi-monthly during their internships to share NOS teaching ideas, assessment ideas, ask questions, and receive feedback. Using the Views of Nature of Science Version B (VNOS-B) preservice teachers' NOS views were identified and found to be adequate. The Stages of Concern about NOS teaching (SOCQ) was used to determine the kinds of concerns the preservice teachers held about NOS instruction. Field notes and voice recordings were used to track conversations at focus group settings, and videotapes were made of science instruction in each internship setting. None of the preservice teachers had mentors who held NOS understandings or who taught NOS, yet results showed that all five preservice teachers explicitly taught NOS in their science lessons, albeit in different ways and to different degrees. Recommendations for creating a community of NOS learners are made.

S3.13.6 Connecting Nature of Science Knowledge and Content Knowledge: An Intervention Study

Erin E. Peters, George Mason University

Nature of science knowledge has consistently been identified as a core goal for students of all grades in the United States because it is thought to provide a framework on which to build content knowledge. However, little empirical evidence has been provided to uphold this claim. This study examines an intervention designed to provide NOS knowledge in an explicit, reflective manner by means of student self-regulation in a quasi-experimental setting. Both groups received the same content knowledge exposure, but the experimental group received NOS instruction via a set of checklists and questions that compared their thinking with that of a scientist. The comparison group received implicit NOS instruction. Findings showed the experimental group significantly outperformed the comparison group in nature of science knowledge and content knowledge. Qualitative data showed that students in the experimental group tended to reflect on and add to their observations during the inquiry, while the comparison group did not. Additionally, when faced with different conclusions based on the same evidence, students in the experimental group returned to the lab to gather further evidence, while students in the comparison group waited for the teacher to resolve differences.

S3.13.7 The Trouble with Scientists Views of Nature of Science

Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign
May Jadallah, University of Illinois at Urbana-Champaign

This paper aims to: (1) critically review studies that examined scientists' views of nature of science (NOS). The review elucidates problematic aspects that cut across many of the reviewed studies and argues that the 'trouble' with scientists' NOS views is largely an artifact of the assumptions underlying many of the studies; and (2) report on an empirical study that examined the views of a group of ten practicing scientists while taking into account the 'lessons' learned from the aforementioned critical examination of the literature. Scientists were individually interviewed about several NOS issues. Later, they provided feedback on their NOS profiles as constructed by the researchers; this procedure was used to ensure an authentic representation of their views. Participants explicated a range of views on the target issues ranging from the 'realist' to the more 'contextual.' Their views were related to their research methodologies and years of experience within science.

S3.13.8 Understanding Students' Conceptions of the Nature of Science through Multiple Assessment Tools

Dana Gnesdilow, University of Wisconsin- Madison
Sarah A. Sullivan, University of Wisconsin- Madison
Anushree Bopardikar, University of Wisconsin- Madison
Sadhana Puntambekar, University of Wisconsin- Madison

The importance of teaching the nature of science (NOS) to students in K-12 settings is highlighted in the benchmarks and standards. Many assessments used to measure students' and teachers' conceptions of the NOS have been criticized. Thus far, a qualitative and quantitative comparison of data collected from different assessment formats (forced choice, open ended-survey, and interviews) taken by the same students has not been undertaken, which was the goal of this study. Three assessments were chosen to test the creative, tentative, and empirical aspects of the NOS: the Modified Nature of Scientific Knowledge Scale (MNSKS), an Open-Ended Survey (OES), and follow-up interviews developed based on the work of previous researchers. Analysis was based on responses from thirteen 6th grade students. Quantitative analysis showed that students had significantly higher scores on the tentative subscale of the MNSKS and that students made significantly fewer responses about the creative and empirical inferential NOS on the OES. Qualitative analysis revealed differences in the percentage of students holding informed NOS views between the MNSKS and OES. Inconsistencies in student responses were found within and between the assessments, creating difficulties in making clear comparisons and determining students' NOS views.

S3.13.9 Rethinking Science Literacy: Critical Tales from the Classroom and Field

Kevin Carr, Pacific University

How can new science teachers critically deconstruct and rethink traditional notions of science literacy? Teacher beliefs about science literacy are influenced by past science learning experiences, notions of "good science teaching" imposed by society, the standards-based discourse of schooling often found in practicum experiences, and the vision for "good science teaching" presented by university methods courses. Critical self-examination of the discourses acting to define science literacy may play a powerful role in allowing for the possibility of new, more critical notions. This poster invites discussion around issues of science literacy and illustrates approaches used to scaffold the rethinking of science literacy by novice teachers in both classroom and teaching practicum settings.

S3.14 Strand 14—Poster Session

S3.14.1 Teachers Experiences in Environmental Education: Negotiating the Complexities

Michael Tan, University of Toronto
Erminia Pedretti, University of Toronto
Gabriel Ayyavoo, University of Toronto
Katherine Bellomo, University of Toronto

Environmental education has in recent years acquired an urgency and momentum. In Ontario, Canada, there has recently been renewed calls to reintroduce environmental education, which had suffered a hiatus after a standalone course was scrapped. In this paper, we report on the results of the early stages of our three year study. In this phase we examine how teachers negotiate the various contradictions and partialities associated with environmental education with a sociopolitical action and transformative orientation. Specifically, a large scale questionnaire aimed at a census style elucidation of trends was conducted, and illustrated with interviews aimed at exploring the narratives that teachers make use of to understand their work and themselves.

S3.14.2 Survey of Students' Environmental Attitudes and Behaviors in High School Environmental Science Courses

Erica N. Blatt, University of New Hampshire
Eleanor Abrams, University of New Hampshire

In recent years, many public high schools have introduced an Environmental Science elective course for 10-12th graders. However, few studies have been done evaluating formal programs in American schools or attempting to determine what should be included in environmental education programs in our schools to promote environmental literacy in the areas of environmental knowledge, skills, attitudes, and behavior. This study utilizes an established survey for measuring environmental attitudes, the New Environmental Paradigm (NEP) scale established by Dunlap, et al, 2000, in order to measure attitudinal change. Behavioral change in students is measured by a second survey, which is an "ecological footprint" providing information about the students' proenvironmental behavior. These surveys are given in a pre- and post-test format to students in an Environmental Science course and their counterparts not enrolled in an Environmental Science course at 8 public high schools (N=257). Regression analysis and independent sample t-tests conducted on the data show the relationship among environmental attitudes and behaviors for these students, document the variability in progress among the different Environmental Science classes, and describe which groups of students are most likely to improve their proenvironmental attitudes and behaviors as the result of taking this type of course.

S3.14.3 Bringing Citizens to Natural Areas: Motivations and Barriers to Participation in Citizen Science

Oksana Bartosh, University of British Columbia
Jolie Mayer-Smith, University of British Columbia
Linda Peterat, University of British Columbia

This research was undertaken to gain a fuller understanding of the motivations and barriers for individuals, particularly urban Canadians and youth to become engaged in citizen science and environmental-experiential learning activities in protected areas and natural spaces. A literature review was conducted that focused on key documents from Canadian and international journals. In addition, 32 program providers and scholars in citizen science and environmental-experiential education across Canada were interviewed. Data from the interviews and literature review were analyzed and compared. From this analysis we provide recommendations for program providers and scholars interested in advancing our understanding of citizen science and environmental-experiential learning.

S3.14.4 Measuring Students' Implicit Attitudes toward Environmental Protection

Tzu-Yu Chou, National Taiwan Normal University
Hao-Chuan Wang, Cornell University
Ting-Kuang Yeh, National Taiwan Normal University
Chun-Yen Chang, National Taiwan Normal University

We apply a new technique, called Implicit Association Tests (IAT) (Greenwald, McGhee, & Schwartz, 1998; Banaji, 2001), for measuring students' attitudes in an implicit and unconscious way. We develops a new IAT test called the environment¡Xconstruction IAT (E/C IAT) and compares it with the nature--built IAT (N/B IAT) developed earlier in Schultz et al. (2004) for validating our operationalization of environmental attitudes. The results showed moderate correlation between implicit attitudes toward nature and toward environmental protection. The parallel between the two constructs was consistent with our expectation and suggested the plausibility of studying environmental attitudes by using the IAT technique.

S3.14.5 The Effect of Demographic Variables on Preservice Teachers' Environmental Literacy

Ozgul Yilmaz Tuzun, Middle East Technical University
Gokhan Ozturk, Middle East Technical University
Gaye Teksoz Tuncer, Middle East Technical University

Environmental education is important for increasing people's awareness towards environmental problems. Remediation of the environmental problems are mostly related to reasoning, behaviors and attitudes of the people, which is also called environmental literacy of people.This study reports the environmental literacy, attitude ,behavior, concern and knowledge of the 560 in a preservice teachers (PTs) in a university. In this study the role of gender, environmental background and major in environmental attitude, concern, behavior, and knowledge – environmental literacy- was explored. The instrument to be used for detecting PTs environmental literacy is the questionnaire, Environmental Literature Test, developed by National Environmental Education and Training Foundation (NEETF & Roper, 2005). Multivariate analysis of variance used to compare the gender, department and environmental background differences on dependent variables; environmental attitude, concern, behavior and knowledge. This study is unique in terms of three aspects. First; this study investigated the effect of gender, major and environmental background on each dimensions of the environmental literacy in one study. Second, this study was aimed to investigate these issues in a developing nonwestern country. Third the participants of this study were preservice teachers who have responsibility of spreading environmental literacy through education.

S3.14.6 Children's Worldviews from China, Singapore and the United States: Implications for Research, Teaching and Learning in Science and Science Education

Bryan S. Wee, University of Colorado
Ya-Wen Chang, University of Colorado
Austine Luce, University of Colorado

Discussions about research, teaching and learning in science should be concerned not only with what is expressed in classrooms but also with underlying messages implicit in educational processes. Researchers and educators alike need to be conscious of "hidden" values that perpetuate certain worldviews at the expense of multiple, valid ways of knowing. This paper is a qualitative comparison of children's worldviews across China, Singapore and the U.S. using children's drawings of the environment, and it is intended to add a valuable dimension to science and science education by highlighting the diversity inherent in fundamental ideas about children's unspoken constructions of, and relationships with, the world across different social-cultural settings. A social-constructivist framework was used to frame data collection and analysis, and a mental model of children's worldviews was developed to frame children's interpretations. Children's worldviews, regardless of nationality, were utilitarian in nature where the environment is viewed as a commodity that supports and extends human existence.

S3.14.7 Elementary Teachers' Science Teaching for Environmental Decision-making

Cory T. Forbes, University of Michigan
Michaela Zint, University of Michigan

Teachers play a crucial role in students' learning about environmental issues and their development of relevant decision-making and problem-solving skills. Here, we developed a survey instrument to measure elementary teachers' beliefs, perceived capacity, and actual teaching practices related to environmental education in the context of science. Our findings suggest that elementary teachers do not differentiate between inquiry practices that promote student learning about environmental issues and those that promote relevant decision-making and problem-solving. Furthermore, teachers report a mismatch between their desire to engage students in inquiry practices to learn about environmental issues, their perceived capacities to do so, and the degree to which they actually engage in these practices. Observed relationships between these findings and the teachers' opportunities for learning have important implications for supporting teachers to engage in effective, inquiry-based science teaching about environmental issues at points along the teacher professional continuum.

S3.14.8 Place-Based Learning Environments and Teacher Development

Carlos Ormond, Simon Fraser University
David B. Zandvliet, Simon Fraser University

This paper describes environmental learning in higher education through two case studies of the learning environment in post-secondary environmental education courses characterized by place-based and constructive pedagogies. In addition, the project validated two forms of a new learning environment instrument for use in pre-service teacher education programs. Current research in learning environments using the PLACES questionnaire has noted that preferred and actual learning environments had a much closer fit in interdisciplinary, outdoor-based learning environments than single disciplined, classroom-based learning settings. The findings from this study further elaborate on these findings, and validate the reliability of the PLACES questionnaire in assessing learning environments in post-secondary settings.

S3.14.9 Design Template for Ecology Professional Development

Claudia Khourey-Bowers, Kent State University
Donald Gerbig, Kent State University

This interactive poster session will offer a design template used for an ecology professional development (PD) program that presented specific ecological content knowledge (CK) and pedagogical content knowledge (PCK) through a multi- dimensional approach to ecological thinking. Fundamental concepts in ecology were taught using various strategies which exemplified four dimensions of feeding-relationships in conceptualizing ecology.

S3.14.10 High School Students' Awareness and Misconceptions Related to Solar Cells

Padmini Kishore, La Mirada High School, CA
James Kisiel, California State University, Long Beach

This paper reports a study on student understanding of the factors that influence the working of solar (photovoltaic) cells. The presence of photovoltaic panels and their applications has increased considerably, raising questions regarding the level of the public's understanding, of how these panels work, especially among the younger generation. While misconceptions related to environmental issues have been reported among high school students, similar studies regarding student understanding of photovoltaic panels have been scarce. The purpose of this study was to assess high school students' understanding of photovoltaic panels. The study was conducted at a public high school in Southern California, among high school biology students who were primarily sophomores. Only one third of the respondents recognized that photovoltaic panels transform light to electricity. In addition, several misconceptions were prevalent among these students. Some believed that solar panels depend on the thermal energy of the sun. Other students mentioned that solar panels might not generate any electricity on cloudy days while a few perceived solar panels as storage devices.

S3.14.11 Undergraduate Students' Attitudes toward Biodiversity and Biodiversity Curriculum

Yu-Teh Lin, National Taiwan University
Hui-Ju Huang, California State University Sacramento

The study presents the processes of developing biodiversity curriculum. The first part was to investigate undergraduate students' attitudes toward biodiversity by using a survey questionnaire. The overall students' attitudes, gender difference and difference between students with or without experiences of conservation activities were analyzed. In summary, students recognized the importance of protecting biodiversity. They agreed that the goal of conserving biodiversity would not be a threat to the continued economic prosperity. However, they also showed conflict attitudes between the need of exploitation of natural resources and the conservation of wildness and wildlife populations. They did not agree that science & technology can solve all problems of biodiversity issues. They recognized that problems of biodiversity issues should not be left to the experts, but they were not confident that they will make a significant contribution to solve problems of biodiversity issues. The implications of the study suggest that there is a need to prepare students for actively taking responsibility on biodiversity issues. The second component of the study was to apply interdisciplinary approach to develop biodiversity curriculum which aims to help students determine their own pathways to sustainable living based on well-informed and critical decision making.

S3.14.12 Denial and Socio-scientific Issues: Understanding Public Resistance

G. Michael Bowen, Mount Saint Vincent University
Valerie Rodger, Dalhousie University

Newspapers and similar media are often used as an information source regarding science issues both by the public and by teachers in classrooms. Conversely, newspapers can allow insights into the public understanding of scientific issues. We collected discussions of global warming issues from the public on-line forums of a national newspaper. Our analysis of these contributions revealed considerable efforts (particularly from certain individuals) to detract from arguments in support of the existence of global warming. This paper summarizes the strategies employed by those frequent posters and their misunderstandings of science practices (such as how knowledge is hardened through a conference-review-publication process) and discusses how we see many of these perspectives emerging from traditional classroom science environments.

S3.14.13 Emphasis Given to Climate Change in State Science Standards: Are States Warming Up to the Science?

Barry W. Golden, Florida State University
Yavuz Y. Saka, Florida State University

This study analyzed the science standards/and/or frameworks of 50 states to gauge the emphasis given to global warming/global climate change (GW/GCC). The analysis was done via a word search for three key items which reveal references to key terms such as "global warming", "climate change", and greenhouse effect". The documents were then coded, on a scale from one to four, based upon how extensive and detailed their framework dealt with GW/GCC. For instance, a framework with standards indicating the importance of understanding GW/GCC, as well as an emphasis on understanding the likely anthropogenic contributions, scored a "4". A framework in which the key concepts did not appear earned a "0". Findings indicated a wide range of variation in how states addressed the issue. Eighteen states earned the lowest possible score, while only five states scored a four. This may be particularly disturbing, given the societal emphasis upon GW/GCC recently, as well as the recency of the standards development, with over 80% of the states' frameworks being done in the last decade.

S3.14.14 Environmental Behavior Change: Influencing Learner Behavior through Environmental Education

Rita A. Hagevik, The University of Tennessee
Carolyn D. Reilly-Sheehan, The University of Tennessee

The Theory of Planned Behavior and the Model of Responsible Environmental Behavior were used to predict the environmental behavior of ninety-seven participants enrolled in six different workshops in the program called, "Living Clean & Green!". Instructor interviews, workshop observations, pre/post knowledge surveys, behavior questionnaires, and post telephone interviews were used to examine the overall characteristics of the program, participants' knowledge, intention to engage in environmental behavior, and actual behavior change. Based on the five variables determined by the models, factor analysis was used to determine the groupings of the questions. The predictive value of attitude, subjective norms, and perceived behavioral control on intention to engage in the behavior was determined. The constructs of the model explained 44% of the variation on intention to engage in the behavior. Three-months after the workshops, the model was not able to predict actual behavior change even though the model had been successful in predicting intention to engage. Interviews of participants, however, did show that some behavior change had occurred in a majority of the participants. Overall, the environmental education program was effective in increasing participants' knowledge, in determining intention to engage in these behaviors and to a degree in changing participants' actual behaviors.

S3.15 Strand 15—Poster Session

S3.15.1 Experts' Perception of Challenges and Opportunities in Science Education in Africa: An Agenda to Accelerate Catch-Up

Peter A. Okebukola, Crawford University, Nigeria
Tunde Owolabi, Lagos State University, Nigeria
Irene U. Osisioma, California State University

At the close of the 20th century, the report card of Africa in science and technology development was depressing. In the last five years however, optimism has risen. We report the findings of a two-year survey of 835 African scientists, science educators, senior policy makers and civil society groups on the major challenges and opportunities for Africa in the 21st century. The study also extracted from the subjects, perspectives on the directions Africa should turn in science and technology education in the next two decades. Four clusters of challenges emerged: low investment in science and technology education; scientific and technological illiteracy; poor science and technology infrastructure; and science and technology human capacity deficit. Elements of a reform agenda for science education in Africa were ranked by the participants in the study. These include increased investment in science education; development of national science education strategy; major rethinking of science teacher education programme and its implementation; greater visibility to environmental education, computer education and population education in the curriculum; promotion of scientific and technological literacy for all; and promoting the participation of girls in science. Important recommendations were made for national and regional science education systems in Africa.

S3.15.2 New York State Regents Examinations: Their Evolution Related to the Current Social Context of Schools

Connie F.C. Woytowich, University at Albany/Colonie Central High School

This paper aims to inform the reader about the evolution of Regents Examinations in New York State, and the effects that measures taken by the New York State Board of Regents and State Education Department have had on the social context of schools. The framework for analysis employs Bourdieu's notion 'social field' and builds on Bourdieu's metaphor of the 'game'. That is, the 'game' of testing in the 'field' of New York State Education Department (NYSED) policy. The resistance movements since the inauguration of the plan for high-stakes testing in New York and the grading policies, particularly in science and math education are discussed. New York's experience with education policy can inform the nation regarding the long-term effects of NCLB, as its consistent testing mandates predate NCLB.

S3.15.3 Turbulence: The Dynamic Interplay of Factors Which Influence Urban Educational Reform

Carla C. Johnson, University of Cincinnati

The reality of reform is that efforts are highly influenced by political (external and internal) pressures rather than educational considerations (Anyon, 1997) and the problems continue to persist and are not being solved. Long-term improvements in education have yet to be realized due to turbulence -- the interplay of variables within the educational system which hinder planning, coordination, and implementation of reform efforts designed to improve instruction and school climate (Author and other, in press). Turbulence is often the invisible elephant in the room, as participants in reform know there are obstacles but sometimes cannot specifically identify the source. This study will reveal the turbulence that teachers participating in a sustained, collaborative, whole-school reform process in an urban district encountered. The reality is that even the best designed, well-intended, reform efforts are subject to external pressures and climate that are difficult to control for. Findings and implications for science education reform will be discussed.

S3.15.4 Leaving Science Behind: A Case Study of Teaching Science in a Rural School amid High Stakes Testing

Georgia Hodges, University of Georgia
Deborah Tippins, University of Georgia

Six years after the enactment of No Child Left Behind (NCLB) inducement, researchers continue to document the successes and failures of the far-reaching legislation. Recent observational studies contend that high stakes state-level testing greatly affects curriculum and instruction (Wills, 2007; Dorgan, 2004) while other studies contend the effect are negligible and indirect (Grant, 2001; Grant, Gradwell, Lauricella, Derme-Insinna, Pullano, &Tzetzo, 2002). Of importance is a group of studies that have focused on the subjects that are not success markers for a school system's Adequate Yearly Progress (AYP). Collectively, these studies show decreased time spent by teachers on these subjects, which includes all science subjects (Spellings, 2007; Spillane, Diamond, Walker,Halverson, & Jita, 2001). This case study is the first to investigate the effects of state-mandated testing on teacher practice in the sciences in a rural area. This study focuses on a rural, K-12 charter school in the southeast United States. Through participant observation, interviews and triangulation with test scores and time spent on science, the authors found teachers continually eliminating science instruction from their daily lesson plans. From the analysis and a literature review, the authors suggest inclusion of science as a marker for states that receive funds from the No Child Left Behind inducement.

S3.15.5 Secondary Science Teachers' Employment System in Asian Regions

Young-Shin Park, Chosun University, Korea
BaoHui Zhang, Nanyang Technological University, Singapore
Hsiao-Lin Tuan, National Changhua University of Education, Taiwan
Yoshisuke Kumano, Shizuoka University, Japan
Xinkai Luo, Guangxi normal University, China Mainland

It is obvious that high quality and committed teacher candidates are important for a better teacher workforce. However, there has been a lack of literature on teacher recruitment and screening process especially in Asian regions. Further, it is more important to prepare teachers from the beginning of potential teacher candidates' education. This paper draws some Asian regions' data to be compared, showing how science teachers are recruited, screened, trained, certified, and eventually deployed. It further discusses strategies on how each in Asian regions has ¡°designed¡± a system to ensure that the best candidates go to teaching profession. Majority of data came from the analysis of documents related to teacher education including those of teacher preparation program at universities and employment system after universities. First of all, each case of teacher employment system will be introduced and compared, then authors proposed a research agenda to further improve the teacher recruitment and training system based on the analysis of Asian regions' secondary science teacher employment system.

S4.1 Presidential Invited Session—Simple Participatory Accelerated Research Kick-Offs (SPARK) Talks

Eleanor Abrams, University of New Hampshire
Len Annetta, North Carolina State University
Bill Boone, Miami University, Ohio
Gayle Buck, Indiana University
George Glasson, Virginia Tech
Tamara Holmund Nelson, Washington State University, Vancouver
Pernilla Nilsson, Halmstad University, Sweden

Do you sometimes sit through NARST presentations wishing the presenter would simply get to the conclusions? Do you secretly enjoy the "FARSE Speed Presentations" and wish real NARST sessions could be presented in an accelerated format so you quickly learn many new things? Do you yearn for more time to interact with interesting conference presenters? If so, this action packed session is for you! Think of Simple Participatory Accelerated Research Kick-Offs (SPARK) Talks as research speed dating. The session will feature numerous speakers on a variety of topics, each given only 5 minutes to present their research findings. These 5 minute research presentations are designed as kick off sessions that will be followed up with dinner with the presenter and colleagues like you who are interested in engaging in interesting conversation on the topic. Each presenter is responsible for posting a sign up list on the conference bulletin board in the registration area for the first 8-10 people who are interested in going to dinner together to discuss the topic presented. The presenter is responsible for making reservations at a local restaurant in advance so that those interested in participating in the dinner event will have a reservation. Each participant is responsible for his/her own meal costs.

S4.2 International Committee Sponsored Session—Symposium: From Teaching to 'Know' to Learning to 'Think' in Science Education

Reinders Duit, Leibniz Institute for Science Education, Germany
Helge Strömdahl, Linköeping University, Sweden
Uri Zoller, University of Haifa, Israel
William C. Kyle, Jr., University of Missouri-St. Louis
Mei-Hung Chiu, National Taiwan Normal University
Chin-Cheng Chou, HungKuang University, Taiwan
Hui-Jung Chen, National Taiwan Normal University
Chun-Feng Tsai, National Taiwan Normal University

Enhancing students' learning is a continuous challenge for most of science educators and researchers in the field of science education. This session is designed to discuss how to move from teaching to "know" to learning to "think" from international perspectives. Five presenters contributing their experiences and expertise to this session are: Reinders Duit from Germany, Helge Strömdahl from Sweden, Uri Zoller from Israel, William (Bill) C. Kyle from USA, and Mei-Hung Chiu with her colleagues (C. C. Chou, H. J. Chen, & C. F. Tsai) from Taiwan. Each will discuss and reflect on the issues that this session was designed for.

S4.3 Strand 1—SC-Paper Set: Understanding Physical Concepts

S4.3.1 Teaching for Understanding in a Prescribed Physics Curriculum: A Comparison of Learning Outcomes in Conceptual Change and Traditional Classrooms

Richard F. Gunstone, Monash University
Pamela J. Mulhall, University of Melbourne

This paper reports research conducted in senior high school physics classrooms in a context of an externally prescribed curriculum and an externally set high stakes examination. Learning outcomes from classrooms with a focus on fostering student conceptual change are compared with learning outcomes from classrooms involving more conventional teaching, in terms of both student conceptual understanding and performance on standard examination problems. A number of steps were taken to increase the ecological validity of the study (that is, to have the study as close as possible to the actual situation being investigated): all classes were taken by the usual physics teacher; teachers were either included in one of the two groups or excluded from both on the basis of interview and classroom observation; the assessments of learning outcomes were developed in conjunction with expert physics teachers; the assessments of learning outcomes were embedded in teacher assessments (so that students saw these as 'assessment that counts'). Two importantly different content areas were used in the research – mechanics and DC electricity. In mechanics, the conceptual group performed substantially better on both forms of assessment (understanding and standard exam problems), and in electricity better on understanding assessment and equally well on standard exam problems in electricity.

S4.3.2 Do Structure Maps Facilitate Expert-Like Problem Solving Strategies In Physics?

Frances A. Mateycik, Kansas State University
N. Sanjay Rebello, Kansas State University
David H. Jonassen, Kansas State University

The overarching goal of this study was to explore whether the use of expert-designed structure maps can facilitate expert-like problem solving strategies by students in physics. We explore the use of structure maps by students in an algebra-based physics course and the evolution of these maps based upon students' feedback collected over one semester. The participants were trained to use structure maps while solving problems sharing similar deep-structure elements. They met for one hour every week to work on the problems using the maps. We report here on the ways in which students used the structure maps during the interviews, the difficulties faced by students as they attempted to use these maps, and the feedback offered by students regarding the maps. We also report on how we changed the maps based on feedback from the students and to facilitate their use during problem solving.

S4.3.3 Analyzing Differences and Similarities in Students' Knowledge Structure Coherence and Understanding of Force

Douglas B. Clark, Arizona State University
Cynthia M. DAngelo, Arizona State University
Sharon P. Schleigh, East Carolina University

The current study investigates two possible hypotheses explaining the conflicting results reported by Ioannides and Vosniadou (2002) and diSessa, Gillespie, and Esterly (2004) regarding students' knowledge structure coherence and understanding of force. More specifically, the current study focuses on potential differences in analytic methods and student populations by applying Ioannides and Vosniadou's (2002) and diSessa, Gillespie, and Esterly's (2004) coding schemes to interviews with 187 students drawn from the United States, the Philippines, Turkey, China, and Mexico. Overall, although interesting systamaticities and variations are observed across countries, the results of the current study align more closely with the findings of diSessa, Gillespie, and Esterly (2004) in supporting elemental perspectives on knowledge structure coherence.

S4.4 Strand 1—Symposium: Collaborations between Scientists and Science Educators: The Grand Challenges and Great Opportunities of the Centers for Ocean Education Excellence (COSEE)

Janice McDonnell, Rutgers University
Chankook Kim, Seoul National University
Howard Walters, Ashland University
Patricia Kwon, COSEE-West
Judy Lemus, University of Hawaii

The ocean is a driver in global climate, it fuels extreme weather, and it provides half of the oxygen on Earth. It is also changing- from the depletion of global fisheries, receding sea ice, changing sea level, and altered biogeochemistry. These changes have brought with them a resurgence of ocean science research and technology and have underscored the importance of a scientifically literate public that understands the ocean and its impact on our planet. However, concepts and topics about the ocean rarely appear in the K-12 curriculum materials or national standards. Moreover, we know little about the teaching and learning of ocean science concepts. Given this poor state of affairs the National Science Foundation has provided funding for a national network of Centers for Ocean Science Education Excellence (COSEE) to improve ocean literacy. A key characteristic of all these centers is the partnerships that they form between scientists and the science educators (researchers and practitioners). The goals of this symposium are twofold: (1) to introduce the COSEE centers to the NARST community, and (2) to present cases of partnerships among scientists and science educators and discuss their affordances and constrains in terms of the research and products generated.

S4.5 Strand 2—SC-Paper Set: Bringing Science to the Classroom: Reasoning, Thinking, Interpretation, and Motivation

S4.5.1 Young Children's Reasoning about Anomalous Data, Evidence and the Design of Tests: Taking Science to School in Kindergarten

Deborah C. Smith, Pennsylvania State University
Carla Zembal-Saul, Pennsylvania State University
Jessica Cowan, Grays Woods Elementary School

Young children's reasoning about anomalous data, evidence, and the design of tests: Taking Science to School in kindergarten This design-based research investigated the recommendations of the National Research Council's report, Taking Science to School (TSS), for science teaching and learning in a kindergarten classroom. The report summarizes research that counters prevailing but outdated views of young children as limited in their scientific reasoning. The first and third authors co-designed and taught a seeds and plants unit to engage kindergarteners in TSS's four strands of scientific proficiency. Children's interviews about science and scientists, and about seeds and plant growth, were videotaped before and after the classroom study. Classroom lessons were also videotaped, and analyzed for evidence of children's progress in the four strands of proficiency. This paper focuses on a subset of lessons, in which children encountered anomalous data – mold – in their "lima beans in a baggie" investigations. We describe how children made progress in "participating productively in the discourses and practices of science," as they made claims related to the evidence in their baggies, posed possible causes for mold growth, and brought in findings from other investigations. Findings are discussed as challenges and opportunities in teaching and learning early childhood science, as young children begin their participation in a scientific community.

S4.5.2 The Effects of Constructivist Classroom Contextual Factors in a Life Science Laboratory and a Traditional Science Classroom on Elementary Students' Motivation and Learning Strategies

Andrea R. Milner, The University of Toledo
Mark A. Templin, The University of Toledo
Charlene M. Czerniak, The University of Toledo

The purpose of this study was to determine the effects of constructivist classroom contextual factors in a life science laboratory and a traditional science classroom on elementary students' motivation and learning strategies. The Constructivist Teaching Inventory was used to examine classroom contextual factors. The Motivated Strategies for Learning Questionnaire was used to examine student motivation and learning strategies. A Wilcoxon nonparametric test determined that constructivist teaching practices were found to occur more often in the life laboratory than in the regular classroom. Although constructivist teaching practices increased at each observation time in both the regular classroom and in the life laboratory, a Friedman test determined that they were not statistically significant increases. Paired sample t tests determined that student motivation and learning strategies were higher in the life laboratory than in the regular classroom overall as well as at each survey time except for learning strategies at Post 1. A 2 x 4 between 3 within repeated measure ANOVA determined that student MSLQ motivation and learning strategy scores in the regular classroom varied statistically significantly by teacher. Student MSLQ motivation and learning strategy scores in the life laboratory varied statistically significantly by teacher. To triangulate data, individual interviews of students were conducted at the end of the semester and revealed students regard the life laboratory as an asset to their science study; however, students do appreciate and value working in the learning environment that the regular classroom provides.

S4.5.3 You Made us Think, Think, Think!: An Illustration of Questioning and its Impact on Interaction in the Elementary Science Classroom.

Hwei Ming Wong, Nanyang Technological University
Aik Ling Tan, Nanyang Technological University

In this paper, we use microanalysis of classroom discourse to highlight instances of teachers' questioning habits in the science classrooms and discuss how this can result in different types of interaction in the elementary science classrooms. We argue that to change teachers' practices in science instruction from one which is largely transmissive in nature to one which is exploratory requires more than just a knowing about what makes up science inquiry. Rather, there are many instructional variables which determine teacher-student interaction -- teachers' theories about how students' abilities and how they learn, their understanding of nature of science, their understanding of their roles as science teachers as well as the ways they craft the learning tasks, all influence interaction in the classroom. The question of interest here is "How can teachers structure classroom discourse that stimulates question- asking?" Insights from this question will serve to increase teachers' awareness of the way they use questions and also help teachers to structure their tasks to foster a classroom discourse which will stimulate question asking and in-depth thought processing by the students and the teachers.

S4.5.4 Students' Interpretation on Hierarchical Graphs of the Structure of Chromosome

Chen-Yung Lin, National Taiwan Normal Univerisy
Show-Yu Lin, Aletheia University
Hsin-Yun Hsieh, National Taiwan Normal Univerisy

Visual representation has becomes more popular in daily lives and science textbooks, and graphs should be a critical component during the process while reading science textbooks, in addition to the text itself. It has been suggested that prior knowledge and cognitive style be two of important factors which may have significant effect on visual thinking. In this study, the research focus aimed to explore the relationship among the interpretation on the graph, prior knowledge and cognitive style. In total there were thirty-three 7th graders, 13-years old, involved in this study and they were interviewed with two graphs. Students' prior knowledge and cognitive style were determined by two instruments, namely, Prior Knowledge Assessment and Group Embedded Figures Test. In this study, the research focus was to explore the relationship among the interpretation on the graph, prior knowledge and cognitive style. It was found that both prior knowledge and cognitive style might affect students' perception on the graph to some extent. It was also found that a graph layout without along with reading habit, such as from top to bottom or from macro to micro, may result in problems in interpretation.

S4.6 Strand 3—SC-Paper Set: Teacher Classroom Practices and Support Systems

S4.6.1 Confidence and Knowledge: Primary Teachers as In-School Science Coordinators

Eleanor A. Brodie, Sheffield Hallam University

Science became a compulsory subject across much of UK primary education during the late1980s with the introduction of the National Curriculum making it a core subject alongside English and Mathematics. A body of research has since emerged focussing on primary teachers' understanding in science and its effect on pupil development. This research has highlighted low teacher confidence as a major issue facing primary science teaching. One mechanism in place to tackle this issue of low confidence is the in-school science 'coordinator' which all primary schools have been encouraged to appoint. This teacher has sole responsibility for the planning of science across the whole school with the principal end-goal of improving standards. The purpose of this study was to focus on the perceptions and attitudes of those responsible for science at Primary level - the science coordinators, with particular attention paid to the educational backgrounds of participating coordinators and it relationship to their professional confidence. The study aimed to explore current needs of these coordinators by drawing attention to both strengths and weaknesses in the role. A grounded theory approach was used to gather and analyse data with theory emerging from the data inductively.

S4.6.2 Elementary Administrators and their Perspectives Concerning Science Education

Christina Fox Call, Brigham Young University
Nikki L. Hanegan, Brigham Young University
Sara M. Wursten, American Leadership Academy

This study surveyed and rated the perspective of elementary school administrators concerning elementary science education. The various roles of the elementary school administrator in leadership and improvement in science were analyzed and graphed. The place of science education in the elementary school classroom was discussed. Careful comparisons were made to ascertain how the recent implementation of nationally mandated testing standards have influenced or changed perspectives of administrators' conceptions of elementary school science. This study used a randomized national survey for data and was analyzed quantitatively. Respondents for this study were elementary school administrators. Survey statements were designed to emphasize two domains: (1) frequency of elementary administrator support, and (2) importance of the task as determined by the elementary administrator. Survey statements were then recorded into three primary categories: (1) frequency of elementary administrator's teaching practices, (2) statements to define the personal role of the administrator, and (3) statements to describe the resources the administrator deemed necessary to effectively teach science. Each set of statements was answered through a Likert scale, which allowed the administrator to qualify the level of support, importance, and frequency. The results suggest that administrators recognized the importance of providing support, however the frequency is low.

S4.6.3 Improvising Inquiry: The Knowledge Required To Engage Students In Model-Building

Danielle B. Harlow, University of California, Santa Barbara

Classroom interactions are unpredictable in inquiry-based instructional contexts, necessitating that teachers transform content knowledge on the spot in response to students' ideas. This is an exceptionally complicated task when teaching aspects of the nature of science, such as explanatory models, because the knowledge that must be transformed includes ideas about the nature of science and the ideas about the investigated phenomenon. I present an example of a teacher who participated in a physics course designed for elementary teachers and subsequently effectively transformed a series of activities to implement with her third graders in a way that allowed students to engage in the practice of developing and testing a scientific model. Comparing the elementary teachers' instruction to that of the physics course shows that the teacher followed an implicit structure of the models of magnetism activity.

S4.6.4 Writing in Elementary School Science: What Types of Writing Do Teachers Have Students Produce?

Nicole J. Glen, Bridgewater State College

Calls for scientifically literate citizens have prompted science educators to examine the role that literacy holds in students' science learning. Although many studies have investigated the cognitive gains of writing in science, few studies have explored how elementary teachers understand the use of writing in science. This qualitative case study of four elementary teachers investigated how teachers used writing during their science lessons. The types of writing that they had students produce reflected their understanding about the kinds of writing that should be used in science, and included four main types: (a) informational- descriptive, (b) procedural, (c) organizer, and (d) narrative/combination writing. These types of writing occasionally mirrored what the teachers believed scientific writing was like, yet rarely attended to conceptual knowledge gains in science. The teachers often used science simply as a context for fulfilling their curriculum's writing competency requirements. Additionally, teachers' pedagogical practices reinforced the idea that science is learned by the transmission of information, and the writing that typically resulted further reinforced this concept. Implications for science educators include attending to teachers' understandings of the nature of science, purposes for writing in science, and the formation of connections between schools' literacy and science curriculum requirements.

S4.7 Strand 4—SC-Paper Set: Secondary Science Teacher Choices and Actions in the Science Classroom

S4.7.1 The Impact of Project-Based Science on High School Minority Students as Mediated by Teacher Knowledge and Practices

David E. Kanter, Temple University

We studied the extent to which a Project-based Science (PBS) curriculum could improve minority high school students' science achievement and attitudes and ultimately their science college and career plans. To do so, we provided professional development to bolster teachers' science content knowledge (CK) and pedagogical content knowledge (PCK) to support teachers using the high school biology PBS curriculum "Disease Detectives: Village Park Mystery" as designed. High school minority students whose teachers used the PBS curriculum improved significantly in some measures of science achievement as compared to a control group whose teacher taught the same content using a traditional curriculum. PBS students maintained their perceptions of the relevance of science where control students experienced steep declines. There were no significant changes in minority student plans to pursue science in either group. The level of PCK teachers achieved with professional development and the frequency of their use of the inquiry activities in the curriculum correlated with the more positive PBS student attitudes. Only teachers' inquiry activity frequency correlated to gains in PBS student achievement. In sum, the success of PBS with high school minority students appears to rely on elements of both teacher PCK and practice.

S4.7.2 Tensions when Teaching Science: How a Teacher Juggles Multiple Demands of Ambitious Pedagogy in an Urban Middle School Classroom

Melissa Braaten, University of Washington
Mark Windschitl, University of Washington

Both pre-service and in-service science teachers require better preparation and ongoing support from the science education community as they work to develop a repertoire of reform-oriented teaching practices. But to provide this preparation and support, we need to better understand how the multiple demands of ambitious pedagogy interact, compete, and influence the pedagogical decision-making of science teachers. In this six-month study, we explore the case of a middle school science teacher who is working across two teaching contexts attempting multiple components of ambitious pedagogy, but who struggles to incorporate challenging teaching practices into her instruction. In the first context, an urban public middle school, we describe the teacher's repertoire of practices and her pedagogical decision-making. In the second context, a non-profit summer enrichment program for low- income students of color, we collaborate with the teacher to push her to try increasingly ambitious science teaching practices. Across these two contexts, tensions arise when this teacher juggles the multiple demands of ambitious pedagogy. We use Windschitl's (2002) framework of tensions arising from attempts at reform-based teaching to characterize the dilemmas faced by this teacher, and we hypothesize how these tensions influence attempts to build sophisticated repertoires of practice.

S4.7.3 Development of Inquiry Skills in Middle School (Grade 7): Analysing the Effectiveness of different Types of Instruction

Sandra Hof, Justus-Liebig-University Gießen
Jürgen Mayer, Justus-Liebig-University Gießen

One demand in science education is to provide students with competences of scientific inquiry. The purpose of this study is to investigate, how middle school students develop inquiry skills as well as content knowledge under various kinds of instruction. The outcomes of three different learning environments are compared: open and guided-scientific-inquiry versus direct instruction. The research design included a pre- and posttest on inquiry skills and content knowledge of photosynthesis with a ten week intervention period in between. The intervention which consisted of eight investigations including the four advised aspects of inquiry: Problem solving, open inquiry, cooperative and context based learning. With this intervention, the competences of inquiry arises, moreover, we could develop the content knowledge as well. Examinating the relation between the aquisition of inquiry skills and the amount of learnt science content knowledge, it is remarkable, that the group which has learnt most of inquiry skills, acquired lesser content knowledge. Furthermore we compared the effectiveness of different kinds of instruction. Our results show that inquiry learning in general is more effective than teacher-centered methods using direct instruction. Moreover, we see a tendency, that open inquiry is the most effective way for the promotion of inquiry skills.

S4.7.4 The Nature of Science Inquiry Facilitation in a High School Environmental Science Class

Anton S. Puvirajah, Georgia State University

This study documented, narrated, analyzed, and interpreted the role of a high school environmental science teacher in facilitating scientific inquiry for her students. Twelve components of scientific inquiry were extracted from literature and used to determine the extent to which the science teacher encouraged scientific inquiry in her students as they participated in a long-term science research project. While many instances of the teacher encouraging scientific inquiry practices were documented, the type of scientific inquiry components encouraged varied considerably. It was found that the teacher encouraged lower order thinking scientific inquiry components more than high order thinking components. This research suggests that design of science learning and teaching strategies should include learning progressions that support students' development of deeper understanding of scientific inquiry. To accomplish this, teachers' understanding of the nature of scientific inquiry and how this can be facilitated fully in the science classrooms should be developed.

S4.8 Strand 5—SC-Paper Set: Undergraduate Research and Laboratory Experience

S4.8.1 Mentoring Takes a Village: Maximizing Undergraduate Research Potential by Building Cohesive Learning Communities

Elizabeth Berkes, UC Berkeley

The pervasive rhetoric around undergraduate research activities casts these internships as opportunities to work with a certain professor or be mentored under a particular scientist. However, meeting the challenge of fostering undergraduate science content knowledge, scientific prowess and integration into the scientific community is a mentoring challenge that involves the whole laboratory or research group and not just the primary investigator. Data for this study were gathered over the course of three years and in three specific contexts: interviews, during everyday lab work, and at weekly laboratory meetings. Three transcripts will be presented, each one demonstrating a skill learned by undergraduates in the context of their work in a biology research laboratory at a prestigious research university. These three transcripts are tied together by three major themes. First, they share a common view that a fundamental aspect of what is gained in a research internship is scientific self- efficacy. Second, they demonstrate that when strong scientific self-efficacy beliefs are developed in an undergraduate research internship, they are often developed through cognitive apprenticeships. Perhaps most importantly, all three of these transcripts demonstrate that the skills undergraduate researchers learn are most effectively and efficiently gained in a cohesive learning community.

S4.8.2 "It Doesn't Really Matter What the Right Answer Is:" A Case-Study on Implementing Inquiry-Based Laboratories at the University Level

Stephen B. Witzig, University of Missouri
Sandra K. Abell, University of Missouri
Frank J. Schmidt, University of Missouri

The U.S. National Science Education Standards provide guidelines for teaching science through inquiry. The difficulty in achieving this vision of the standards at the university level lies in what instructors mean by inquiry and how they implement it. In an NSF-funded project, "CUES: Connecting Undergraduates to the Enterprise of Science," faculty developed new inquiry-based laboratory curriculum materials using a "mini- journal" approach. The mini-journal is designed as an alternative to the cookbook laboratory and represents the way that scientists do science. This study took place in an upper-level biochemistry course where the instructor converted traditional cookbook laboratories into mini-journals. The research design followed a qualitative approach including laboratory observations throughout the semester, semi-structured interviews with the instructor and 8 students, and analysis of course documents. The findings describe the classroom and laboratory teaching and learning strategies that were implemented, and the views of instructor and students. This research provides a concrete example of how an instructor incorporated inquiry-based curriculum materials in an upper-level college science laboratory.

S4.8.3 Characterizing the Inquiry Experience in a Summer Undergraduate Research Program in Biotechnology and Genomics

Maya R. Patel, Cornell University
Deborah J. Trumbull, Cornell University
Elizabeth Fox, Cornell University
Barbara Crawford, Cornell University

This study builds on our prior work examining students' learning during 10-week summer undergraduate research experiences (UREs) in laboratories described as being at "the forefront of plant biotechnology and genomics." We continue to be interested in how the laboratory contexts contributed to undergraduates' understandings of contemporary science and development into science practitioners. Our current study used a range of data to 1) characterize interns' research projects and experiences, 2) explore changes in students' understandings about the nature of scientific inquiry (NOSI) and 3) explore students' epistemological development. Findings indicate that students with higher levels of independent inquiry and autonomy in the research process developed a stronger sense of ownership of their research project than those who did not. Findings also indicate that attributes of the mentor played a more important role in characterizing students' experiences than attributes of the students. Gains in understanding aspects of NOSI were shaped by students' epistemological development and the nature of their internship experience. Implications and suggestions for further research on the effects of URE experiences are discussed.

S4.8.4 Student Perceptions of Research Intensive Science Courses at University

Roeland M. Van der Rijst, Leiden University, The Netherlands
Gerda J. Visser-Wijnveen, Leiden University, The Netherlands
Jan H. Van Driel, Leiden University, The Netherlands

The present study was conducted in the context of strengthening linkages between research, teaching and learning at universities. Although it is commonly expected that strengthening the teaching-research nexus will stimulate student learning, not much is known about the ways science students actually perceive and value this nexus in undergraduate courses. Therefore, a questionnaire was developed to investigate how students perceive the relationship between research and teaching in undergraduate science courses, and how this perception is related to their evaluation of these courses. The questionnaire was administered among a sample of students (n=103) who were enrolled in various undergraduate science courses. The results revealed that, in general, students tend to think that learning about research, and to do research, is important and has a stimulating impact on their learning. In these specific courses, however, students perceived relative little possibilities to be involved in research, and learned little about their teacher's research. At the same time, the courses were evaluated quite positively. It is suggested that if teachers would give their students more possibilities to be involved in research activities, students would probably appreciate this.

S4.9 Strand 6—SC-Paper Set: Examining Student Science Experiences Outside of School

S4.9.1 The Nature of Science in Afterschool Science: The Development of Two New Instruments

Kelly M. Pirog, University of Massachusetts Amherst
Allan Feldman, University of Massachusetts Amherst

The context of the study is on of the NSF's Academies for Young Scientists (AYS). In this AYS, groups of 4-6 teachers become part of a practicing scientist's research group. They engage with the scientist for an extended time period (6 months or more) and are legitimate peripheral participants in the research group. The 8-12 4th- 8th grade students in each after school club, through the mediation of the teachers, become members of the scientist's research group. The purpose of this paper is to report on the development and use of two new instruments for assessing teachers' and students' views of the nature of science (NOS) as they participate in the scientific research groups. Our instruments were designed to be administered to a large number of participants and be analyzed efficiently; to gather information about teachers' views of teaching the NOS in addition to their views of NOS; and to be appropriate for elementary school students. We present how we developed the instruments, the ways that they can be used, and what we learned from using them about this AYS project.

S4.9.2 Students, Scientists and Science in a Research Institute Classroom

Bev France, The University of Auckland
Jacquie Bay, The University of Auckland

A science education programme situated within a leading scientific research institute was developed to provide secondary students with a teaching and learning experience that shows students the links between the science they are studying in school and the practice of modern scientific research. These experiences include the exploration of a current research project, hands-on practical work and a discussion session with scientists where they ask questions about their work, life and scientific issues of interest to them. The discourse of question and answer provided an avenue for an analysis of meaning making between the participants. Questionnaires (n=399) were administered to 16 -17 year old students prior to the visit where they predicted the questions they would ask of scientists and post visit to identify the best questions of their question and answer session. Quantitative analysis of question types and qualitative analysis of 40 interviews showed that students' questions reflected their interest in scientists' lives as well as the applications of science. The findings indicated that question analysis provided information about how some students were making sense of the experience. It may also indicate that concept development is not independent of an emotional reaction to the learning situation.

S4.9.3 Reach for the Sky: Improving STEM learning for Anishanabe Students

Gillian H. Roehrig, University of Minnesota
Tamara J. Moore, University of Minnesota
Stephan Carlson, University of Minnesota
Brant Miller, University of Minnesota
Selcen Guzey, University of Minnesota
Joel Donna, University of Minnesota

Reach for the Sky (RFTS) is an innovative out of school science and engineering program striving to make learning science, math and engineering more culturally relevant to Anishinabe youth. It is designed for students in grades 5-8 and offered on the White Earth Reservation. RFTS students learn modern science, math and engineering through traditional American Indian stories and hands-on activities during a five-week summer program. The goal of the program is to increase STEM knowledge, attitudes and skills for Native American students. 33 students completed the RFTS program and completed a variety of engineering design challenges: rockets, egg-drop, rubber-band cars, and three-wheel bikes. Students also used a variety of technologies throughout the RFTS program including engineering design software, probeware, and iMovie. The research utilized a mixed-method design (Tashakkori & Teddlie, 1998). Students' knowledge of STEM, engineering design and inquiry skills, and attitudes toward STEM were assessed using multiple measures, including written content tests, surveys, observations, and student artifacts. Students showed significant growth in STEM learning and attitudes toward STEM over the course of the summer program.

S4.9.4 Curricular Design to Support Students Interactions with Their Communities

Jennifer L. Eklund, University of Michigan
Nonye Alozie, University of Michigan

As science educators approach teaching of emerging sciences, such as molecular genetics, they face the "grand challenge" of not only developing materials for the classroom but also preparing students for the changing world. Increased student understanding will help students more aptly interact with the changing world and help make them active participants in the policymaking process as molecular genetics comes to the forefront. To address this challenge we developed a unit intended to not only support student learning but to prepare students to interact with their communities about molecular genetics content in an informal learning environment. In conjunction with the enactment of the unit, "DNA Night" events were held. At the events students presented activities they had completed during the enactment of the unit to members of their community including parents, teachers, school and district administrators, and members of local community organizations. The activities and features included in the unit materials provided an important foundation for the interactions that students had with others during the "DNA Night" events. Here we report on the features of the unit materials designed to support students' interactions with others outside of class and on the ways in which students interacted with their community.

S4.10 Strand 7—Symposium: Preparing Preservice Teachers to Integrate Inquiry Science with Language and Literacy Instruction for English Language Learners

Trish Stoddart, University of California, Santa Cruz
Michael Stevens, California State University, Stanislaus
Marco Bravo, Santa Clara University
Jorge Solis, University of California, Berkeley
Ramon De Vega Jesus, California State University, Stanislaus
Eduardo Mosqueda, University of California, Santa Cruz

This symposium describes the findings of a research and development project that focused on preparing pre-service elementary school teachers to integrate the teaching of science, language and literacy to English Language Learners (ELL). Although the number of ELL is rapidly increasing, few teachers are being prepared to teach them. The innovative science teacher education program described in the symposium was based on the CREDE Five Standards for Effective Pedagogy (CFSEP), a set of teaching practices associated with increased achievement of ELL. The CFSEP include: 1) Language & Literacy; (2) Collaborative Inquiry; (3) Complex Thinking; (4) Contextualization; and (5) Joint Productive Activity. Researchers conducted an experimental design study to analyze the impact of the CFSEP teacher education program on the developing beliefs and practice of novice teachers. The symposium presents the results of pre- and post-program comparisons of control and experimental group student teacher performance on a science content assessment and attitude surveys. The symposium also presents the results of classroom observations of student teacher science instruction during their student

teaching practicum. The findings demonstrate that the CFSEP intervention significantly improved student teachers' confidence in teaching science and their knowledge of and ability to implement culturally and linguistically responsive pedagogy in their science instruction.

S4.11 Strand 8—SC-Paper Set: Problem-Based Learning

S4.11.1 Taking a Step towards Professional Development through Assessments in a Problem-Based Learning (PBL) Project

Sunethra Karunaratne, Michigan State University
Joyce Parker, Michigan State University
Mary Lundeberg, Michigan State University
Matthew J. Koehler, Michigan State University
Jan Eberhardt, Michigan State University

What do teachers learn from assessment data to improve students' science understanding? To examine this question, we studied teachers' analyses of student work and inferences drawn from them. Seventy-eight teachers were participants in a professional development (PD) project that utilized problem-based learning and teacher research as tools for deepening pedagogical content knowledge with the goal of improving teachers' ability to learn and study and improve their practice. Participants chose a science content area to focus on during the PD and gave two openended, application questions on that subject to their students. Teachers were shown a way to tabulate students' responses. Based on their analyses of their assessment data, teachers were asked to make inferences about their assessment tasks and ways to improve their instructional units. These analyses were the main data source for this study. Analysis of data using grounded theory revealed that teachers' have some important skills, such as identifying weaknesses in the wording of questions, required for using assessment to guide curriculum development. However few teachers went beyond identifying that they needed "more" instruction to suggest specific foci or instructional strategies to improve their units. Thus this study articulates a critical area for PD programs to focus on.

S4.11.2 Gauging Changes in Teachers' Science Content Knowledge: Can Problem-Based Professional Development Lead to Deeper Understanding of Science?

Tom J. McConnell, Ball State University
Joyce M. Parker, Michigan State University
Jan Eberhardt, Michigan State University
Jeannine C. Stanaway, Lansing Community College
Merle Heidemann, Michigan State University
Mark Urban-Lurain, Michigan State University

In this presentation, we will share findings of an extensive study of teacher content learning in the PBL Project for Teachers, a professional development program for K-12 science teachers that used Problem-Based Learning (PBL) to deepen participants' science content knowledge. The researchers analyzed teachers' written responses to pre- and post-assessments, transfer tasks, and resolutions to authentic science problems, as well as videotaped discussions of problem-based dilemmas, to understand how teachers' understanding of science concepts change during the summer workshops. The findings of the study revealed that teachers entered the program with a superficial understanding of examples and patterns in science, but lacked a deep understanding of the explanations and theories behind the phenomena. Participants in the PBL Project showed an increase in content knowledge, with teachers developing new understandings of the patterns and explanations in specific content areas. The findings of this study support the use of PBL as a strategy for professional development.

S4.11.3 Professional Development that Targets Problem-Based STEM Education for Secondary Science Teachers

Anila Asghar, The Johns Hopkins University
Roni Ellington, Morgan State University
Barry Aprison, The Johns Hopkins University
Eric Rice, The Johns Hopkins University
Francine Johnson, The Johns Hopkins University
Glenda Prime, Morgan State University

Scholars and practitioners emphasize the significance of cross-disciplinary STEM (Science, Technology, Engineering, and Mathematics) education that encourages students to learn about the natural world through exploration, inquiry, and problem solving experiences. Through surveys, qualitative interviews and focus groups this study investigated/ /how secondary science and mathematics teachers' responded to the problem-based learning approach to STEM education during a professional development program. Teachers' perceived challenges in implementing STEM instruction are also highlighted. This investigation offers insight into how university-based professional development programs can support secondary educators' understanding and ability to use problem-based STEM inquiries in their classrooms.

S4.11.4 Constraints or Structural Necessities? Teachers' Conceptualizations of the 'Messy' Elements of PBL

Rashmi Kumar, University of Pennsylvania
David Jarvie, Educational Consultant

This study uses an ongoing professional development series to investigate how teachers of different content area specializations, teaching assignments, age groups, and locations of schools differentiate between the perceived constraints of problem-based learning (PBL) and its essential structural features. The percentages of teachers who utilize inquiry-based and student-centered approaches like PBL are rather low (Hollweg & Hill, 2003; Linn, 2006; Penuel et al., 2007). The study examines teachers who demonstrate resistance in implementing PBL in their classrooms, and identifies the mediating factors that help them overcome their resistance. The constraints identified by the teachers are divided into two groups—scale of influence and area of control. The proposed paper presents strategies that can potentially increase the percentages of teachers who use PBL on a consistent basis. The presentation will present findings that cut across multiple sources of data, including profiles of participating teachers, comparisons of their pre and post conceptualizations of PBL, and analyses of teachers' responses to instructional modules.

S4.12 Strand 10—SC-Paper Set: Evaluating the Effect of Nanoscience and Material Science Curriculums

S4.12.1 Design, Implementation, and Evaluation of the Effectiveness of a 12-Hour Middle School Instructional Unit for Size and Scale

Cesar Delgado, University of Michigan
Harry B. Short, University of Michigan
Joseph Krajcik, University of Michigan

Based on a theoretically and empirically derived learning progression for size and scale, we designed, implemented, and evaluated the effectiveness of a 12-hour instructional sequence for size and scale, in a summer science camp for middle school students from a low-mid SES public school district. Following a construct-centered design (CCD) approach, we designed activities using microscopes, custom-made computer simulations, and 2-D and 3-D scale models. We implemented them in a hands-on format including student- centered discussions. The strand is contextualized with the driving question, "How can nanotechnology keep me from getting sick?" The learning goals are to build conceptual understanding and factual knowledge of the size of key scientific objects such as the atom, DNA, viruses, bacteria, and cells, as well as appropriate units of measurement. Pre- and post interviews revealed that students significantly increased their average level along the learning progression, and greatly increased their knowledge of measurement units smaller than the millimeter. This knowledge helped them improve the accuracy of their knowledge about the size of key scientific objects like the atom, viruses, and cells. Students improved more on their accuracy of absolute sizes than relative sizes, with implications for instruction and the learning progression.

S4.12.2 Design-Based Research on Materials Science: Modelling and Inquiring Sound Attenuation

Roser Pinto, Universitat Autonoma de Barcelona
Digna Couso, Universitat Autonoma de Barcelona
Maria Isabel Hernandez, Universitat Autonoma de Barcelona

In this paper we present first results of a design-based research of a teaching/learning unit on Sound Attenuation, which is part of a cross-national research-based curriculum project on Materials Science. The common theoretical basis for curriculum-design is focused on an inquiry-based and modelling approach and the use of ICTs to support it. In our project, a partnership of secondary-school teachers and researchers has been established as a "learning community". Researchers have proposed theoretical issues for the pedagogical approach and supported and documented (through participatory observation) aspects of teachers' changes across this challenging process of design and implementation. Different assessment activities have been used to analyse students' outcomes and first results regarding a model of sound attenuation in terms of energy are presented here. The idea of this analysis is to become feedback for an iterative design-implementation-evaluation approach to curriculum development within a design-based research framework.

S4.12.3 Durability of Conceptions of Big Ideas in Nanoscience

Thomas R. Tretter, University of Louisville
M. Gail Jones, North Carolina State University
Jennifer Wolf, University of Louisville

The durability of conceptions of foundational nanoscience ideas experienced through a week of classroom instruction by 193 high school physics students was investigated. The instructional sequence was organized around key big ideas in nanoscience that were identified by a panel of 39 national experts in nanoscience and nanoscience education. A follow-up questionnaire was administered to these same students approximately 6 months after the conclusion of the instruction to investigate the durability of the learning that occurred. Results showed that some core big ideas in nanoscience were strongly retained: the importance and implications of the varying surface area-to-volume ratio for nanoscale objects; conceptions of the relative size variations within the submacroscopic (invisibly small) world; and importance of the development of appropriate tools for the advancement of science. In agreement with other research, results showed that students' cognitive strategies for organizing their nanoscience learning relied on sequential kinesthetic and holistic kinesthetic learning modalities.

S4.12.4 The Impact of a Teaching Intervention for Size and Scale based on Conceptual Variations

Eun Jung Park, Northwestern University
Su Swarat, Northwestern University
Greg Light, Northwestern University
Denise Drane, Northwestern University

Size and Scale has been identified as a critical concept for understanding nanoscience. Although Size and Scale is often considered a relatively easy concept, instructional experience and previous research studies have revealed limited understanding of the concept and learning difficulties even at the college level. This paper reports results of a study focused on conceptual understanding of Size and Scale in a freshman engineering design course. Aims of the study were to (1) explore undergraduate students' conceptions of "Size and Scale", and (2) assess the impact of a teaching intervention designed to make students aware variations in conceptual understanding of Size and Scale. Fourteen students answered open-ended survey questions on conceptual understanding of "Size and Scale" before and after the intervention and completed an interview about their survey responses and reasons for changes in their responses over time. Results suggest that the intervention helped students develop more sophisticated conceptions of Size and Scale. Students showed better understanding of Scale in terms of size continuum. In addition, the intervention facilitated the transition from thinking in terms of absolute differences towards thinking in terms of proportions, and led students to become aware of the difference between linear and logarithmic scale.

S4.13 Strand 11—Symposium: Place as a Construct in Science Teaching, Learning and Curriculum Design: Implications for Addressing Culture and Equity

Giovanna Scalone, University of Washington
Philip Bell, University of Washington
Miyoun Lim, Georgia State University
Erika Tate, University of California, Berkeley
Sameer Honwad, Pennsylvania State University
Christopher Hoadley, Pennsylvania State University
Erich Schienke, Pennsylvania State University
Brent Yarnal, Pennsylvania State University

Attention to place has been largely absent in science education except as a backdrop or setting in which teaching and learning happen (Gruenewald, 2003). However, place as a construct--although long discussed in fields such as anthropology and geography—has yet to be seriously addressed as an integral part of science learning. In this symposium, we explore some ways in which place figures as a complex, multilayered construct in science learning and its implications in addressing issues of equity and culture in science education—specifically, the learning pathways that are available to youth. We explore question such as: how do youths' sense of place intersect with science and environmental education? how do science teachers appropriate sense of place into their teaching practices? We hope that the symposium can help further the conversation about place addressing a "grand challenge" in science education—incorporating issues of culture and equity in science learning—and the opportunities it affords us in thinking about how to consider the settings of youth's lives as more than mere backdrops, but as integral parts of their identities and learning.

S4.14 Strand 12—SC-Paper Set: How Can Modeling Technologies Promote Understanding of Microscopic Phenomena?

S4.14.1 Research on Universal Design for Learning in Grades 3-6 Science Education

Robert Tinker, The Concord Consortium, MA
Carolyn Staudt, The Concord Consortium, MA
Andrew A. Zucker, The Concord Consortium, MA

The Concord Consortium's Universal Design in Science Education project, funded by the National Science Foundation, is developing software so that elementary teachers can better meet each student's needs. The concept of Universal Design for Learning (UDL) has been applied to teach reading but to a much lesser extent to teach science. Features of the software that will be shown briefly include the different languages available, the scaffolded questions that provide extra help as needed, coaches, and a Smart Graph. The portal through which teachers obtain reports will also be demonstrated. The primary focus of the presentation will be on research conducted with 15 teachers located in two large urban school districts who have been using the software. Data will be presented to address the primary research question, namely: to what extent are the features and approach developed as part of this project useful to students and teachers? We will report data about the frequency of use of different UDL features, based on the log data, and on the connection between students' learning needs and which UDL features they use. Data will also be presented about teachers' and students' opinions of the utility of different UDL features.

S4.14.2 Building Models from Scratch

Brian Foley, CSU Northridge
Jarod Kawasaki, Cleavland High School

Model building is a key activity for science students because it promotes inquiry, conceptual understanding and representational literacy. For decades researchers have demonstrated the potential of using computers to support students' model building (e.g. LOGO, Model-IT, ThinkerTools). But these tools (and modeling in general) have yet to gain widespread use in science classrooms. This project engages teachers in developing modeling activities that fit within their curriculum using the newly developed Scratch software (scratch.mit.edu). Scratch allows students (and teachers) to create or modify computer models with very little training on how to program. The Scratch Science group meets regularly to explore the Scratch software, develop lesson ideas and review results.

S4.14.3 Students' Understanding of Protein Structure and Function via Computerized Molecular Modeling

Miri Barak, Technion - Israel Institute of Technology
Rania Hussein-Farraj, Technion – Israel Institute of Technology

Recent research on technology-enhanced instruction identified the need for providing learners with knowledge representation tools. Accordingly, our research focuses on a new biochemistry learning unit, aiming at introducing scientific innovations and promoting understanding of 3D structures of bio-molecules. The research's goal was to examine whether, and to what extent, learning via computerized molecular models (CMM) affect students' understanding of biochemistry. The research included 234 grade twelve students that were divided into three comparative groups: (a) traditional curriculum without the use of CMM, (b) new curriculum with student's hands-on practice of CMM, (c) new curriculum with teacher's demonstrations of CMM. The mixed methods model was employed by using pre-post-questionnaires, class observations and semi-structured interviews. Findings showed that the use of CMM enhanced students' conceptual understanding and their ability to transfer across the four levels of chemistry understanding: microscopic, macroscopic, symbolic and process. Students and teachers, asserted positive attitudes, claiming that CMM facilitated their understanding of the macromolecules' spatial structures. In our talk we will present the research findings and discuss the benefits and barriers of integrating CMM within the context of biochemistry learning. We will also present instructional strategies and lessons-to-learn for further implementation.

S4.14.4 Can Drawing Molecular Ideas Improve Learning from Computational Visualizations?

Zhihui Helen Zhang, University of California, Berkeley

In this study the value of drawing after viewing a computational dynamic visualization of molecular reactions is evaluated. The research compares students who draw their ideas to students who select snapshots to show the sequence of the reaction. Students in the drawing group developed a more integrated understanding than those in the selection group. Drawing enables students to test their own interpretations of the visualization. Selection could be achieved by matching the alternatives to recalled images. Posttest results suggest that generating a drawing of a chemical reaction rather than selecting leads to more coherent connections between the dynamic and static representations of chemical phenomena.

S4.15 Strand 13—Symposium: Research on Science Issues of Social and Personal significance: Understanding Students' Decision-Making, Creating Meaningful Curriculum, and Educating Teachers

Teresa Greely, University of South Florida
Meghan E. Marrero, Columbia University
Jennie S. Brotman, Columbia University
Aarti Mallya, Columbia University
Brendan E. Callahan, University of South Florida

This symposium focuses on education around "science issues of social and personal significance"—that is, issues with connections to science that have relevance to people's social and/or personal lives and decisions. We intend this term to include both "socioscientific issues" (SSI) as well as science-related issues connected to more personal choices such as nutrition, medical care, and sexual health. We present five papers focused on these kinds of issues. The first four papers address middle and high school students' reasoning, decision-making, and applications around issues related to "ocean literacy" and personal health (e.g. nutrition and HIV/AIDS), issues not significantly addressed in the science education literature. The fifth paper looks at teachers' perceptions regarding the teaching of a range of SSI in high school biology classrooms. Collectively, our work spotlights the following three "Grand Challenges" towards realizing a vision for science education that influences the decisions and actions that matter to students' lives and the world around them: understanding students' decision-making, creating meaningful curriculum, and educating and supporting teachers.

S4.16 Strand 14—SC-Paper Set: Enhancing Student Learning through Environmental Education

S4.16.1 Student Conceptions of Global Warming and Climate Change

Daniel P. Shepardson, Purdue University
Soyoung Choi, Purdue University
Dev Niyogi, Purdue University
Umarporn Charusombat, Purdue University

The purpose of this study was to investigate student conceptions of global warming and climate change. The study was descriptive in nature and reflected a cross-age design involving the collection of qualitative data from 122 secondary students from the Midwest, USA. These data were analyzed for content in an inductive manner to identify student conceptions. The categories that emerged from the student responses reflected different degrees of sophistication of student conceptions about global warming and climate change. Based on these findings we make curricular recommendations that build on the student conceptions, the IPCC Findings, the NRC (1996) science education standards, and NOAA's climate literacy framework.

S4.16.2 Field Science: A More Inclusive Science for High School Students?

Terry M. Tomasek, Elon University
Catherine E. Matthews, University of North Carolina

This paper compares the descriptions of typical scientific research practices enacted in field ecology with those field science practices enacted by high school students during two weeklong residential summer herpetology camps and six school year follow up sessions. Fifty-four high school students, over two summers, participated in studies of reptiles and amphibians including aquatic and terrestrial turtle mark/recapture studies, and vernal pool surveys. We used active and passive trapping as well as artificial cover to attract organisms. We found that field ecology observational research is accessible to high school students at least partially due to the highly emergent nature of this type of science. Additionally, social interactions were critical to establishing community and communicating ecological field practices among participants. Field ecology may provide greater authenticity and inclusiveness for today's high school students.

S4.16.3 Addressing the Challenges in Understanding Ecosystems: Why Getting Kids Outside May Not Be Enough

Tina A. Grotzer, Harvard University
Christopher J. Dede, Harvard University
Shari Metcalf-Jackson, Harvard University
Jody Clarke, Harvard University

Research shows that students have difficulty achieving understanding of many fundamental ecosystems concepts Our previous research demonstrated that focusing on the underlying causality (domino, cyclic, mutual, relational) can be an effective means of teaching the concepts. The research reported here investigates sixth graders' understanding of ecosystems concepts and their teachers' attempts to help them address their difficulties. Through pre- and post-assessments, open-ended interviews conducted before, during, and after learning, students' in class responses, drawings, and written explanations, a set of assumptions were identified that interact with how students interpreted ecosystems and food web concepts. These included balance and flux, passive energy transfer, opportunistic feeding relationships, caloric storage, competition and availability. Teachers' attempts to teach the concepts through simulation activities and other classroom activities suggest that some concepts are more difficult to learn in the classroom than others. Concepts such as non- obvious causes, and time delays and spatial gaps between causes and appearance of effects, and population effects were challenging to teach outdoors or in the classroom. We hypothesize that simulated computer environments might be a useful resource in teaching the concepts.

S4.16.4 Learning About Ecology through Causal Concept Mapping

Rod D. Roscoe, Vanderbilt University
Nancy P. Morabito, Vanderbilt University
Gautam Biswas, Vanderbilt University

National science standards emphasize the importance of ecology education for students' understanding of interactions among living and nonliving components of the world around them. In this project we explored the use of concept mapping to facilitate learning of ecology. Ninety fifth grade students created maps about river ecosystems over a two-week period, and completed written assessments before and after the mapping activity. Students' answers to open-ended questions were analyzed to assess learning about several key principles: interdependence, less-visible entities, photosynthesis and respiration, and balance. Concept mapping appeared to help students gain overall and in each target concept. Gains were strongest for students' knowledge of less-visible entities and interdependence. It is argued that concept mapping specifically supports learning of such concepts by a) making typically ignored ecosystem components more explicit and salient and b) visualizing networks of causal relationships. However, the static nature of concept maps may be less effective for understanding balance and dynamic equilibrium.

S5.1 Publications Advisory Committee Sponsored Session—Symposium: Publication in the Journal of Research in Science Teaching

Angelo Collins, Knowles Science Teaching Foundation
Amy Dai, University of Maryland
Wayne Breslyn

Participants in this session will become familiar with the submission, review, and the communication process of the Journal of Research in Science Teaching. This session welcomes all those who are interested in submitting and publishing articles in JRST or anyone who would like to become a reviewer for the journal. JRST Editors, Associate Editors, Editorial Board Members, reviewers, and JRST Editorial Office Staff will be present to share information, experiences, and answer questions.

Strand 1: Science Learning, Understanding and Conceptual Change
S5.2 Strand 1—SC-Paper Set: Nature of Science and Thinking about Thinking

S5.2.1 Exploring Coherence between Grade Six Children's Views of the Nature of Science and Their Views of the Natural World

Robyn Garlick, University of Cape Town
Rudiger C. Laugksch, University of Cape Town

The views of a sample of South African Grade Six children are examined in regards to the nature of science (NOS) and the natural world, in order to investigate possible coherence between the two domains. Data were collected by means of written questionnaires and extensive interviews. This paper forms part of a larger study, and three of the cases are compared here. Emerging patterns suggest that a knowable, naturalistic, positive and resource-orientated view of the natural world coheres with informed views of the empirically- based and tentative aspects of NOS. The opposite worldview type (i.e., unknowable, super naturalistic, negative and conservationist views of the natural world) coheres with informed views of the theory-laden, culturally and socially-embedded, and imaginative aspects of NOS. In attempting to improve students' understandings of NOS, science educators perhaps need to consider the way in which they present the natural world to students.

S5.2.2 Students´ Beliefs on the Nature of Science and the Development of Inquiry Competence: A Longitudinal Study

Kerstin Kremer, Justus-Liebig-University Gießen
Detlef Urhahne, Ludwig-Maximilians-University Munich
Jürgen Mayer, Justus-Liebig-University Gießen

An important educational objective in international science education standards documents is that students´ engagement in inquiry should help them develop a sophisticated understanding of the nature of science (NOS). In contrast to this, educational research suggests that students´ NOS beliefs are inconsistent with goals of inquiry-based science learning approaches. In order to address this research problem a pre-post-study on students´ inquiry competence and NOS beliefs accompanying an intervention study with experimental group and control group on the effects of an explicit inquiry-based learning approach was conducted as part of the German National research project "biology in context" (bik). NOS beliefs and inquiry competence of about 300 lower secondary students from the post-test sample are reported. The correlations of students´ NOS beliefs in post-test and their longitudinal increase in inquiry competence differ between experimental group and control group. In the control group there is no remarkable relationship whereas the experimental group shows significant correlations. Both groups improved their inquiry competence from pre-test to post-test, but only in the experimental group improvement in inquiry competence and adequate NOS beliefs are related to each other. These results suggest a positive effect of explicit fostering of inquiry competence on students´ adequate NOS beliefs.

S5.2.3 The Relationship of Pupils' Epistemology, Metacognition, Cognitive Structures and Scientific Achievement: A Path Analysis Study

Chao-Ming Huang, National Taiwan University
Chin-Chung Tsai, National Taiwan University of Science and Technology

Relevant research highlighted the importance of learner's epistemology or nature of science as well as their metacognitive processing. Relevant research indicated the epistemology, metacognitive processing and critical thinking are viewed as important aspects of internal learning control. Previous article revealed a three-layer hierarchical framework, including epistemology, metacognition and cognitive structure. This study tried to explore student scientific achievement test based on this proposed three-layer hierarchical framework, including cognitive structure, metacognition and view of nature of science. This research collected a group of sixth-graders performance (n=108), including their view of nature of science, metacognition, cognitive structure and achievement test. Path analysis was conducted and the finding showed that the view of nature of science had strong indirect effect on achievement test. The view of nature of science was mediated by the variables, including metacognition and cognitive structure. Metacognition played a direct role in predicting students' cognitive structure and achievement test. It also highlights the important role of students' view of nature of science. Moreover, it revealed that the variable, students' view of nature of science, was superior to the metacognition. The findings supported previous proposed a three-layer hierarchical framework.

S5.2.4 Using Students' Conceptions of the Nature of Scientific Knowledge to Inform Dimensions of Epistemological Beliefs and the Nature of Science

Julie M. Kittleson, University of Georgia

A challenge in science education is guiding students to develop meaningful conceptions of science, including conceptions of the nature of scientific knowledge. Student should understand how the nature of scientific knowledge relates to solving science-related problems and participating in scientific practices, both inside and outside the classroom. This challenge leads to opportunities to explore how to characterize students' understandings. This paper considers third graders' conceptions of the nature of scientific knowledge, and findings are considered in relation to epistemological beliefs and nature of science (NOS). Two dimensions of epistemological beliefs and NOS, along with data from two third grade students, are used to illustrate how students' conceptions inform these dimensions. Both epistemological beliefs and NOS provide ways of tapping into ideas about stability and tentativeness, but examining students' conceptions across contexts reveals nuances of students' understandings. These nuances may provide guidance for modifying existing measures of students' understandings of the nature of scientific knowledge to better account for how students understanding the nature of scientific knowledge.

S5.3 Strand 2—SC-Paper Set: Fostering Professional Relationship and Student Experiences in Science Education

S5.3.1 Pedagogical Repairs for Dealing with Trouble in a Science Internship

Pei-Ling Hsu, University of Victoria
Wolff-Michael Roth, University of Victoria

Given that students cannot know beforehand what they are about to learn, trouble is inevitable and necessary events in the process of learning. Therefore helping students to deal with troubles has become an important issue in education. The study aims to understand how participants repair troubles into learning opportunities during a high school students' science internship. Data sources include observations, field notes, and video recording throughout the science internship. Drawing on conversation analysis, we identify different forms of pedagogically relevant conversational repairs that transforming troubles into learning opportunities to support students' further participation. These pedagogical repairs can serve as useful resources for teachers to help students deal with and learn from troubles.

S5.3.2 A Phenomenological Exploration of Secondary Science Students' Experiences during First-Year Implementation of Project-Based Learning

Amy E. Trauth-Nare, Indiana University
Gayle A. Buck, Indiana University
Meredith A. Park Rogers, Indiana University

Project-based learning (PBL) reflects recent recommendations for science education reform and holds promise for supporting and enhancing student learning through investigation of real-world, standards-based problems. However, implementation is often problematic as it requires teachers to modify established instructional and pedagogical practices and compels students to reconceptualize their role in learning. The purpose of this research was to develop an understanding of student experiences in a science classroom during first year implementation of project-based learning. Through interpretive phenomenological analysis, a narrative account of students' experiences was developed. Results of the analysis indicated that students recognized the differences between PBL and traditional forms of learning and were willing to engage in PBL when they perceived the science topics to be relevant. Students also expressed a need for teachers to provide them with appropriate scaffolds and timely feedback about the progress of their learning. Phenomenological descriptions of students' lived educational experiences broaden the scope of our understanding about what it means to learn science in a project-based classroom. The results of this study should inform science educators involved in subsequent curricular reforms.

S5.3.3 Co-Teaching in the University of Pennsylvania's Science Teacher Institute. Collaboration between University Faculty and High School Teachers

Cristobal Carambo, University of Pennsulvania
Constance Blaisie

Coteaching has proven to be an effective teaching modality that allows for the creation of dynamic collaborative relationship that foster shared perspectives and co-responsibility for the learning environment. Coteaching was introduced at the inception of the University of Pennsylvania's Science Teacher Institute in an effort to complement the content knowledge of university faculty with the practical knowledge of a high school educator. Since then, coteaching collaborations have become an accepted teaching arrangement in the majority of our graduate degree courses. This longitudinal research documents the ways in which these relationships have evolved over time and how the co teachers have influenced and modified each other's praxis in their efforts to co-construct a curriculum that is responsive and relevant to the needs of in-service teachers. Each of these collaborations offers a unique opportunity to investigate the interaction

between teachers with radically different life histories and perspectives on science education. The research holds promise for subsequent teacher development programs as it explores how to create a pedagogy that is both rigorous and relevant to practicing educators enrolled in professional development programs. This is of critical importance if we wish to foster genuinely positive change in the quality of science education.

S5.3.4 Do Students Experience Project-Based Laboratory Curricula as Motivating? A Study of an Organic Chemistry Laboratory Curriculum

Gail S. Horowitz, Yeshiva University

A research study has been undertaken in order to characterize and describe the intrinsic motivation of students who participated in a project-based organic chemistry laboratory curriculum. The intent of this curriculum was to provide students with a motivating environment of authenticity, suspense and autonomy, by allowing them to adapt and test out a synthetic experiment of their choosing. A qualitative, ethnographic approach was utilized to examine the intrinsic motivation of students who experienced the curriculum. The study also explored the potentially mediating roles of students' achievement goal orientations, as well as their academic and professional interests. Results showed that all students, without exception, viewed the autonomous aspects of the curriculum as positive. However, the student experience of the authentic and suspenseful aspects of the curriculum was varied. Additionally, mastery oriented students were more likely to experience the curriculum as motivating, especially if they perceived of its degree of challenge as moderate (not too difficult, but not too easy).

S5.4 Strand 3—SC-Paper Set: Primary Science Teachers' Knowledge and Beliefs

S5.4.1 Constructing a Multiple Choice Test to Measure Teachers' Pedagogical Content Knowledge in Primary Technology Education

Ellen J. Rohaan, University of Technology, The Netherlands
Ruurd Taconis, University of Technology, The Netherlands
Wim Jochems, University of Technology, The Netherlands

Pedagogical Content Knowledge is found to be a crucial domain of teacher knowledge. Studies in the field of primary technology education showed that it is related to pupils' increased learning, motivation, and interest. The common methods to investigate teachers' Pedagogical Content Knowledge are complicated and time consuming. Hence, a challenge in measuring teachers' Pedagogical Content Knowledge is to construct an instrument that is time and labor efficient and makes it possible to investigate large sample sizes. This paper illustrates how a multiple choice test to measure teachers' Pedagogical Content Knowledge in primary technology education was designed and validated. The procedure of test construction and the first results are presented. It is concluded that the systematic procedure that was followed is effective. In addition, statistical analyses showed that test-retest reliability is moderate. Data collection in larger samples is needed in order to find more statistical support for the psychometric properties of the test.

S5.4.2 Data in Search of a Theory: A Dual Coding Theory Analysis of Elementary Teachers' Science Learning

Suzanne M. Levine, University at Albany
Cheryl Sheehan, University at Albany
Audrey B. Champagne, University at Albany
Vicky L. Kouba, University at Albany

A mixed methods study revealed that changes in teachers' science content knowledge occurred after the teachers participated in a science methods course taught with an emphasis on designing representations of science principles. Qualitative and quantitative analyses were performed on teacher responses to open-ended questions requiring the explanation of physical phenomena. Further investigations of teachers' responses on the course post-test contextualized by their prior science knowledge, the content of their course assignments, and contributions made during in-class whole and small group discussions provide a multi-layered perspective on how the teachers learn science, and the influence of multiple representations on that learning. Representation features on the pre-test and post- test were reexamined according to a Dual Coding Theory (DCT) framework. Recent research in DCT emphasizes the importance of facilitating referential connections across verbal and nonverbal representations in promoting concept understanding and recall that can be later applied to different contexts. A model of the effects of multiple representations on the process of the teachers' learning and reflection emerges, offering new insight into the relationship between teacher pedagogical content knowledge and the role of multiple representations in science learning.

S5.4.3 Classroom Inquiry Style: A Missing Link Interconnecting Content Knowledge, Topic- Specific Science Teaching and Orientations toward Teaching Science

Annmarie R. Ward, Penn State University
Carla Zembal-Saul, Penn State University

This comparative case study investigates interrelationships among topic-specific science teaching events, consistencies in how individual preservice elementary teachers implement inquiry-based teaching (classroom inquiry style, CIS), content knowledge (CK), and orientation toward teaching science (OTS) for three elementary student teachers. This study represents the third component of a broader research agenda investigating the interface between substantive content knowledge and pedagogical content knowledge for inquiry-based science teaching. Findings include: 1) All three participants' OTS emphasized commitment to inquiry-based teaching but varied in rationale underlying this commitment; 2) Across all participants, CIS profiles were more consistent with OTS than CK, except with respect to the CIS aspects of scientific rigor and coherence of investigations; and 3) Across the three student teachers, these latter two CIS aspects were more consistent with limitations in CK than OTS. Our overall findings indicate the importance of examining topic-specific and general science teaching strategies when investigating the influence of CK or conceptions of science teaching on teaching practice. Information from this study will inform research on the influence of depth of CK, OTS, and aspects of CIS on elementary teachers' PCK development, and elementary teacher preparation and professional development programs focusing on teaching science using inquiry-based strategies.

S5.4.4 Exploring Elementary Preservice Teachers' Beliefs and Knowledge about Science Teaching and Learning Emerging From Metaphor Writing

Eulsun Seung, Indiana State University
Soonhye Park, University of Iowa
Ratna Narayan, Texas Tech

This study identified conceptual themes that represent preservice teachers' beliefs about the role/image of the science teacher and the knowledge bases about inquiry based science teaching. We asked the participants, who were enrolled in the elementary science methods course, to develop personal metaphors regarding the role/image of a science teacher/teaching and to write a rationale paper to support their metaphors. The conceptual themes that reveal preservice teachers' beliefs were assigned to three categories: the traditional view, the constructivist view, and a neutral view. Based on the conceptual themes, each participant's belief was identified as the traditional view, the constructivist view, or a mixed view. By comparing the conceptual themes between pre and post metaphor writing, this study also showed the change in preservice teachers' beliefs about science teaching. Eight knowledge bases about inquiry based science teaching were identified and compared from the pre and post metaphor writing. The results of this study indicate that metaphor writing is useful for clarifying preservice teachers' implicit beliefs and knowledge about science teaching and learning. This study also suggests that metaphor writing can be a useful tool in evaluating the extent to which the goals of the elementary methods course have been achieved.

S5.4.5 Tenet Building: Researching the Place of Generic Science-Content Free Activities to Develop Elementary and Kindergarten Teachers' Understanding of the Nature of Science

Rena Heap, University of Auckland

This study examines the effectiveness of the use of generic science-content-free activities to develop understandings about the nature of science (NOS). The research participants were practicing primary and early childhood teachers (n=25) enrolled in part-time University study. The purpose of the research project was to identify the understandings of the nature of science of these teachers and map the development of understanding over the duration of a five-month science course in order to identify shifts in understanding and aspects of NOS resistant to change. Improving NOS understandings is complex and requires an approach that addresses conceptual change. Therefore, the generic science-content-free activities were strategically embedded throughout the course so that the teachers could approach them as decontextualised NOS activities, or could relate the generic NOS activity to the science content being covered at the time, as contextualised activities, if they made those connections. Data was collected using open-ended questionnaires, selected items from the Views on Science-Technology-Society (VOSTS) questionnaire (Aikenhead, Ryan & Fleming, 1992) and the teachers' regular reflective journal writing. Analysis of the data obtained showed a considerable shift in teachers' NOS views and showed a relationship between these shifts and the use of the generic science-content-free activities.

S5.5 Strand 4—SC-Paper Set: Inquiry and Nature of Science in the Secondary Science Classroom

S5.5.1 Capturing Urban Middle School Students' Voices on the Use of Science Inquiry in their Classrooms

Irene U. Osisioma, California State University
Chidiebere Onyia, Lynwood Unified School District, California
Mercy Ogunsola-Bandele, Adamawa State University, Nigeria

Abstract The present study sought to explore middle school students' perception of the kind of science instruction going on in their classrooms. Data was collected using a five point Likert type survey instrument that was administered to 262 middle school (Grades 7& 8) students in six middle schools in Southern California. This instrument consisted of demographic information and thirty nine statements organized in clusters to elicit responses on a number of statements about students' responses about their 1) emotional disposition toward science, 2) perception of their understanding of the usefulness of science and 3) perception of the implementation of and their emotional dispositions towards inquiry based instruction in their classrooms. Results showed that students expressed positive emotion toward science and science inquiry, understood the usefulness of science to their everyday lives and confirmed the implementation of inquiry-based instruction in their classrooms.

S5.5.2 Characterizing Middle School Science Teachers' Informal Formative Assessment Strategies and Their Effects on Student Inquiry Skills

Joseph A. Brobst, University of Delaware
Eric Eslinger, University of Delaware

We investigated the types and frequencies of informal formative assessment (IFA) utilized by two middle school science teachers and one reading specialist in the context of a software-based inquiry genetics unit. Four types of IFA were identified: mechanical, procedural, content, and metacognitive. The two classroom teachers most frequently engaged students in procedural or content IFA while the reading specialist devoted equal attention to procedural, content, and mechanical IFA. While both the classroom teachers and the reading specialist engaged students in some metacognitive IFA, the frequency with which they did so was relatively low in comparison to other IFA types. Case study evidence is presented which suggests a strong relationship between the frequency with which students were engaged in metacognitive IFA and resultant gains on a test of inquiry skills. Implications for future research on IFA and development of IFA-focused teacher support are discussed.

S5.5.3 Comparison of Views about Inquiry-Based Teaching Held by Science Teachers from Hong Kong, Mainland China and United States

Siu Ling Wong, The University of Hong Kong
Benny H.W. Yung, The University of Hong Kong
Yu-ying Guo, Beijing Normal University, China
Norman G. Lederman, Illinois Institute of Technology
Judith S. Lederman, Illinois Institute of Technology

We report on an international collaborative study which aims to investigate and compare the views about inquiry-based teaching among science teachers in the US, Beijing and Hong Kong who have different experience in inquiry-based teaching and come from different cultural backgrounds, representative of the West, the East and where West meets with East respectively. Ten teachers from each participating regions reviewed the videos of four physics lessons and completed a questionnaire indicating their views on each lesson. They were also asked to provide reasons to explain whether each lesson is a good example of inquiry-based teaching. We identify significant differences on a number of aspects including "formulating explanation from evidence", "arguing and communicating explanation" and "safety measures in an investigation". The results provide a rational basis for the design of teacher training programmes which aim to shape teachers' conceptions of inquiry-based teaching. This will improve the quality of learning of science and most importantly develop students' inquiring ability which is transferable to solving real-life problems in a scientific and systematic manner. It also helps researchers better understand their colleagues from other countries and realize that inquiry is not a construct with a universal definition.

S5.5.4 Converging Paths: Change in the Beliefs about Teaching and the Nature of Science amongst Certified and Alternatively Certified Secondary Science Teachers

Jonah B. Firestone, Arizona State University
Krista Adams, Arizona State University
Julie A. Luft, Arizona State University
Jenn Neakrase, Arizona State University
EunJin Bang, Iowa State University
Irasema Ortega, Arizona State University
Sissy Wong, Arizona State University

In recent years, scrutiny of teacher certification programs has increased. As part of a larger study examining beginning secondary science teachers' experiences in various types of induction programs, we compared certified (N=33) to non-certified (N=32) teachers in their beliefs of how to teach science and their understanding of the nature of science. The authors employed Hierarchical Linear Modeling (HLM) to construct individualized growth models of the certified and non-certified teachers. The result of this analysis indicated that both groups' responses converged over time in regards to their beliefs about teaching science. In addition, both groups' responses became significantly more positivist in their understanding of the nature of science.

S5.5.5 Investigating Elementary Students' Nature of Science Views

Esme Hacieminoglu, Selcuk University, Turkey
Ozgul Yilmaz Tuzun, Middle East Technical University, Turkey
Hamide Ertepinar, Middle East Technical University, Turkey

The purposes of this study were to explain the development and validation of a new instrument for assessing elementary students' views of the Nature of Science (NOS) and to give detailed information about the elementary school students NOS views with respect to grade level. The sample included 4044 students enrolled in sixth, seventh and eighth grade elementary schools located in Ankara, Turkey.Data collection was carried out during the spring 2008. Confirmatory factor analysis was run to determine the factors of the NOS scale. Descriptive statistics and one way ANOVA were used to determine students' understanding of NOS in terms of grade level. The final version of NOSI included 20 items. These items were loaded in four factors namely, the distinction between observation and inference(OI), the role of imagination and creativity in generating scientific knowledge(IC), the tentative nature of scientific knowledge(TE), and the empirical nature of scientific knowledge(EM). Cronbach's alpha reliability of this version was calculated as .63. Results indicated that elementary students had favorable understanding of the EM while being uncertain about understanding of TE and IC. Moreover, low means of OI indicated that elementary students didn't differentiate observations from inferences.Grade Level had significant main effect on students' understanding of NOS aspects.

S5.6 Strand 5—SC-Paper Set: Current Themes in Evolution Pedagogy

S5.6.1 Evolution and Personal Religious Belief: Christian Biology-Related Majors' Search for Reconciliation at a Christian University

Mark W. Winslow, Southern Nazarene University
John R. Staver, Purdue University
Larry C. Scharmann, Kansas State University

The goal of this study was to explore Christian biology-related majors' perceptions of apparent conflicts between their understanding of evolution and their religious beliefs. Fowler's theory of faith development and Parks' model of college students' faith provided a structural-developmental theoretical framework for explaining the role of faith in students' meaning making. This naturalistic study utilized a case study design of 15 undergraduate biology-related majors at or recent biology-related graduates from a mid-western Christian university who had completed an upper-level course on evolution. The broad sources of data were interviews, course documents, and observations. Outcomes indicate that most participants were raised to believe in creationism, but came to accept evolution through evaluating evidence for evolution, negotiating the literalness of Genesis, recognizing evolution as a non-salvation issue, and observing professors as role models of Christians who accept evolution. Participants who operated in conventional faith dismissed contentious issues in an effort to avoid ambiguity and perceived tensions. Participants who operated in higher faith stages tended to confront their perceived tensions and worked towards reconciliation. This study lends heuristic insight to researchers and educators seeking to understand the complex processes by which Christian biology-related majors approach learning about evolution.

S5.6.2 Reinforcing Macroevolutionary Misconceptions: Students' Interpretations Of Textbook Diagrams.

Kefyn M. Catley, Western Carolina University
Laura R. Novick, Vanderbilt University
Courtney Shade, Vanderbilt University

This paper reports data from a larger study of undergraduates' interpretations of particular evolutionary diagrams. In two studies we investigated how university students with stronger and weaker backgrounds in biology interpreted evolutionary relationships depicted in four evolutionary diagrams. Study 1 investigated interpretation of these representations, while in a second study we asked a new group of students how they interpreted what subjects in Study 1 meant when they used the terms evolved into/from and ancestor/descendant of. The results of these studies suggested persistent misconceptions that fall broadly into the following categories: (a) evolution as an anagenic rather than a cladogenic process, (b) evolution as a teleological (purpose-driven) process, and (c) confusion between individuals (organisms) and groups of individuals (taxa). This paper reports the results and implications of Study 1 as they pertain to undergraduates' interpretations of two particular diagrams depicting the evolution of horses and the human genus Homo. In light of our results, we make recommendations about the use of particular diagrams in biology education.

S5.6.3 Testing a Model of Representational Competence Applied to Phylogenetic Tree Thinking

Kristy L. Halverson, University of Missouri
Sandra K. Abell, University of Missouri
Patricia M. Friedrichsen, University of Missouri
J. C. Pires, University of Missouri

Representations are a critical way to express scientific knowledge. However, there is limited research investigating how students gain representational competence in biology, specifically in evolution. Kozma and Russell (2005) proposed a set of core skills required to use representations to develop a model of representational competence for chemistry education. We investigated the viability of this model for use with phylogenetic representations. In this study, we used pre/post tests, interviews, weekly reflective journal entries, field notes from course observations, and student responses to course assessments to learn how upper-level college biology students developed representational competence with phylogenetic trees. We found that a) the original model of competence levels required modification in order to apply to phylogenetic representations, b) developing competence in tree building required an additional skill set, and c) students held multiple levels of representational competence dependent upon the task. Given the suggested modification, the findings support the transferability of the Kozma and Russell representational competence framework to phylogenetic tree thinking. Our revised model will inform the design evolution curriculum and maximize the instructional potential of using phylogenetic representations.

S5.6.4 Does the Nature of Science Instruction Influence College Students' Learning of Biological Evolution?

Wilbert Butler, Tallahassee Community College
Sherry A. Southerland, Florida State University

Does the Nature of Science Instruction Influence College Students' Learning of Biological Evolution? Abstract In the past decade, there has been a great deal of emphasis on the teaching and learning of biological evolution. However, the state of public understanding of evolution remains woefully lacking. This limited understanding affects evolution/science literacy, research, and academia in general. The purpose of this study was to investigate the role an explicit, reflective teaching approach to the nature of science plays in supporting student learning of evolution. In this quasi-experimental study there were two treatment groups, both introductory biology courses: A) a NOS rich, explicit, reflective treatment group and B) an implicit, traditional approach (with limited, implicit treatment of NOS). In the NOS rich class, the aspects of NOS were highlighted throughout the semester and students discussed and wrote about the NOS aspects that they identify as being suggested in the activities and reading assignments in learning about evolution. The traditional NOS class experienced the same activities, discussions, and writing assignments in reference to the evolution lessons but without NOS emphasis. Data were collected using the CINS, MATE and course workproducts before, during and after instruction. Results indicate that student learning of biological evolution was significantly higher in the NOS rich course.

S5.7 Strand 6—Symposium: Informal Science Institutions and Learning Sciences: Intersections of Theories, Methods, and Implications to Practice

Heather Zimmerman, Pennsylvania State University
Molly Reisman, King's College London, England
Maria Xanthoudaki, National Museum of Science and Technology Leonardo da Vinci, Italy
Mele Wheaton, University of California, Santa Cruz
Jennifer DeWitt, King's College London, England
Sandra Murriello, State University of Campinas, Brazil
Jesus Piqueras, Stockholm University, Sweden
Bronwyn Bevan, Center for Informal Learning and Schools at the Exploratorium

In this special symposium, an international group of researchers from informal science learning institutions and universities in the United States, Europe, and Latin America come together to host a discussion about the synergies that can result from joining learning sciences research approaches and theories with research and practice occurring in informal science learning institutions. We see this symposium, composed of two sets of panels - the first focused on concepts and the second on methodologies - as engaging practitioners, designers, and researchers in a rich dialogue about how we understand learning through learner-centered studies, designs, and research projects in informal institutions. By bringing people in the informal science education and learning sciences communities together, new theories and research methods can be brought to the fore to further what we know of STEM learning across the lifespan (pre-school, school-aged youth, families, educators, working adults, senior citizens, etc.). The majority of the eight scholars (and one alternate) that make up the panel are authors of the forthcoming Issue of the Journal of Museum Education Intersection of the Learning Sciences and Museum Education.

S5.8 Strand 7—Symposium: Developing a Common Research-Based, Words-to-Images Language: The ViSTA Teacher Educator Community

Malcolm Butler, University of South Florida
Robert Hollon, University of Wisconsin, Eau Claire
Karynne Klein, Georgia College and State University
Paula Lane, Sonoma State University
Kate Popejoy, University of North Carolina, Charlotte
Roberta Aram, Missouri State University
Maria Lawrence, Rhode Island College
Janice Meyer, Texas A&M
Deborah Smith, Penn State

The Videocases for Science Teaching Analysis project has developed five online, videocase modules for use in K-8 science teaching methods courses. The symposium will begin with a description of the project and examples of key tasks in the modules. We will also describe the ways in which we have worked with a team of pilot and field study instructors. We will share the observations we have made about the value of such an opportunity for teacher educators to work together. In particular, we will emphasize the opportunity to develop a shared, research-based language that is even more powerful because we have the opportunity to examine this language in the context of shared video analysis. The symposium will include contributions from 9 (of our 74) pilot instructors, all of whom are involved in the current field study, and will explore the following focus questions: What is the value of such a shared "words-to-images" language for teacher education and for research? How is such a shared language and the collaboration with other teacher educators changing the way these instructors think about their teaching of preservice teachers? How is it changing the way they think about their own growth as teacher educators?

S5.9 Strand 8—SC-Paper Set: Communities of Practice

S5.9.1 Professional Learning Communities, Teacher Change, and Student Achievement

Gail Richmond, Michigan State University
Daniel Birmingham, Michigan State University

This paper explores a subset of data from a six-year, large-scale project designed to foster reform-based urban science teaching through the development and support of K-8 teachers' communities of inquiry. Based on an analysis of interviews, study group talk, videotaped lessons, and student achievement data, we propose a model for professional development which centers on how professional learning communities contribute, over time, to establishment of trust, taking of risks, create conditions for shifts in perceptions about student abilities and needs and in professional identity and ultimately lead to transformation of practice.

S5.9.2 Three Dimensions of Teachers' Collaborative Inquiry: Using Data to Improve Science Teaching & Learning

Tamara Holmlund Nelson, Washington State University
David Slavit, Washington State University
Angie Deuel Foster, Washington State University
Anne Kennedy, Washington State University

With the increased emphasis on accountability for student learning, there is an associated movement in school districts for data-driven decision making. This research looks at a three- year professional development project that employed a professional learning community (PLC) framework for engaging teachers in collaborative inquiry. This paper presents a theoretical framework used to analyze three dimensions of teachers' interactions within the PLC: their dialogic interactions as they moved through an inquiry cycle; their emergent stance toward the nature and value of student data; and, the degree of simplicity and complexity manifested in their data selection, collection, and analysis. The framework is used to analyze the interactions within a high school science PLC as they focused on improving students' scientific conclusion writing. These teachers developed a tool for diagnosing students' conclusion writing in order to provide feedback, targeted instruction, and, finally, assess student learning over time. As a result of their inquiry process, they saw a significant improvement in students' abilities. This research contributes to understanding what teachers might achieve through collaborative inquiry and some of the supports that helped them in their developmental trajectory along three dimensions.

S5.9.3 Lesson Study: Professional Development for Improving Classroom Practice

Robin R. Smith, Florida State University

Teacher professional development is, by all admissions, absolutely central to improving educational quality in our schools. A promising approach that has been successful in its home country is Japanese lesson study, a teacher-led, learning community form of professional development used mainly in science and mathematics. This study used a multiple case study approach to investigate how lesson study conducted on science lessons at one elementary school may assist teachers in directing their own professional growth in the areas that they identified as in need of improvement. Themes that emerged especially during interviews were related to teachers improving their practice and gaining a sense of professionalism about their growth as educators. As the teachers collaborated in lesson study, the data suggested that they developed a greater sense of self-determination to seek ways to improve their individual practice, as well as teaching and learning throughout the school, using lesson study. This study confirmed that lesson study provided many of the experiences that the literature on high-quality professional development has identified. It is apparent that teachers who are collaboratively involved in a supportive setting such as lesson study can become empowered to determine the activities which will best lead to improvement in teaching.

S5.9.4 Challenges and Opportunities Associated with Community-Based Professional Development: A Model for Sustaining Reform-Based Science Teaching in Urban Settings

Viola Manokore, Michigan State University
Gail Richmond, Michigan State University

This paper explores a subset of data from a six-year large-scale project designed to foster reform-based urban science teaching through the development and support of teachers' communities of inquiry. Based on an analysis of interview and study group data from teacher participants, we propose a model for professional development which centers on the nature and impact of the affordances and constraints arising from the multiple communities in which teachers work. Membership in teacher professional communities affords teachers opportunities to collaborate, to build confidence in their practice and to enact reform-based science teaching. Challenges that teacher face include state and district accountability measures and enactment of reform-based science teaching in environments in which traditional teaching has greater value. We discuss ways such affordances might be maximized and constraints minimized in an effort to sustain change and scale-up efforts.

S5.10 Strand 9—Symposium: Promoting Professional Identity Development through Science Teacher Action Research

Allan Feldman, University of Massachusetts Amherst
Tarin Weiss, Westfield State College
Elaine Howes, University of South Florida
Rachel Mamlok-Naaman, Weizmann Institute of Science
Karen Goodnough, Memorial University of Newfoundland

This collaborative presentation offers insight into how science education researchers examine the significant role teacher action research plays in helping teachers construct and re- construct their personal and professional identities. Teacher action research and its accompanying stories and intellectual narratives serve as a mechanism for researchers to study the relationship between factors, such as student/ teacher voice, accountability, and learning, and identity development. Researchers retrace the goals, intentions, and models of teacher action research and their relation to their research with science teachers (pre- and in- service) and students in search of different pathways toward personal and/or professional identity development. Researchers also share innovative methods for capturing (e.g. digital imaging or narratives) and analyzing (e.g. ecological lens, dialogic validity or existentialism) identity development, while simultaneously supplanting traditional for more transformative approaches to engaging in teacher action research. It is argued that action research is not an abstract construct, but a process by which teachers act, learn, develop, and change their possible selves. Researchers pose interesting questions, methodological issues, moral/ ethical concerns, and recommendations for how teacher action research can foster professional learning and identity development.

S5.11 Strand 10—Symposium: Assessment Linked to Middle School Science Learning Goals: What Middle School Students Know

Cari F. Herrmann-Abell, Project 2061 / AAAS
Jill A. Werthiem, Project 2061 / AAAS
L. Karina Nabors, Project 2061 / AAAS
Jo Ellen Roseman, Project 2061 / AAAS

This symposium will address what middle school students know about key science ideas found in AAAS's Benchmarks for Science Literacy (BSL) (AAAS, 1993) and the NRC's National Science Education Standards (NSES) (NRC, 1996). The work is part of a multi-year, NSF-funded project to develop assessment items aligned to middle school content standards for 16 topics in science, mathematics, and the nature of science. In this symposium, we will focus on: (1) what students know, what strong misconceptions they have, and what they don't know or are not sure about; (2) how the knowledge of sixth, seventh, and eighth grade students compares; and (3) whether revisions made to items as a result of pilot testing lead to predictable changes in student answers on subsequent testing.

S5.12 Strand 12—Strand Invited Symposium: Visualizations for Science Learning: Molecular Workbench, Virtual Worlds, and Handheld Computers

Robert Tinker, Concord Consortium
Constance Steinkuehler, University of Wisconsin, Madison
Chris Quintana, University of Michigan

Many scientific ideas are hard to learn in part because they are highly abstract or they occur beyond our direct perceptions to observe or manipulate: too large, too small, too fast, too slow, or too complex. With the help of new and powerful technologies, visualizing scientific ideas becomes more scientifically accurate and more instructionally feasible than ever before. This symposium invites three ***Presenters:*** (1) Dr. Robert Tinker on the Molecular Workbench, a highly interactive computational model of atoms, molecules, and their interactions that is embedded in its own browser that can be used to scaffold inquiry-based learning in many topic areas, (2) Dr. Constance Steinkuehler on massively multi-player online games in a virtual environment that fosters the development of system-based and model-based collective reasoning among players, and (3) Dr. Chris Quintana on Chemation, a molecular animation tool for hand-held computers. As a discussant, Dr. Marcia Linn will synthesize these presentations, summarize the past and current status of visualization use in science learning, and provide her perspective on future research and development of visualizations. Each participant will have 20 minutes of presentation, followed by the discussant's synthesis. The audience will have 15 minutes to interact with the presenters and the discussant.

S5.13 Strand 13—Poster Symposium: Argumentation, Epistemic Operations and the Nature of Science

In this poster session, a group of scholars from different countries in Europe and the Americas present theoretical perspectives, empirical studies and informed discussion on the contributions that the philosophy and the history of science can make to an in-depth analysis of the scientific argumentation processes that occur in science education. In particular, the authors are interested in the 'epistemic operations' fostered by the use of scientific arguments in the classroom. The relationship between this 'epistemically-oriented' scientific argumentation and an understanding of the nature of science is also examined.

S5.13.1 Argumentation Strategies in Learning and Teaching Chemistry

María Eugenia De la Chaussée Acuña, Universidad Iberoamericana de Puebla, Mexico

Neither teaching nor learning sciences are easy processes. Teachers and students share the task to find ways to experiencing, understanding, reasoning and judging reality and knowledge, the first to be taught and the second to be learned. We can't learn anything that hasn't been really understood. We might try to memorize it and attempt to show we know something we really don't, something we haven't understood or judged. The purpose of this research is to show and analyze the difficulties and certainties in the teaching and learning of chemistry. In this research the focus is specially centered on effective argumentative strategies used by teachers to enable their student's capacity of learning. The research is based on the cognitive perspective of Lonergan (1999) and it uses a sociolinguistic methodology (interpretative qualitative) (Cazden, 1989).

S5. 13.2 Argumentation and Epistemic Criteria: Learning Reasons for Reasons

Richard Duschl, Pennsylvania State University
Gregory J. Kelly, Pennsylvania State University

Scientific argumentation is based on the relations evidence has to explanations. These relationships are varied and progress from decisions about measurement and observation, to decisions about (1) what data to use as evidence, (2) how to model/represent the evidence and (3) how the evidence fits with explanations. The first part of the paper explores the progression of epistemic criteria across the Evidence to Explanation continuum. However, argumentation in classroom settings requires certain considerations for establishing epistemic learning communities. The second part of the paper examines issues concerning social engagements and the content of those engagements in order to make science classrooms places where dialectical discourse interactions like argumentation can occur. The paper concludes with recommendations for future research on argumentation.

S5.13.3 Cool Argument: Investigating the Epistemic Levels and Argument Quality in Engineering Students' Written Arguments about the Peltier Effect in Refrigeration

Sibel Erduran, University of Bristol, UK
Rosa Villamañán, Universidad de Valladolid, Spain

In this paper, we investigate 15 university engineering students' written arguments in the context of the thermodynamics principles involved in refrigeration. The students were given writing frames to complete reports following investigations on thermoelectric coolers, sometimes called thermoelectric module or Peltier cooler. The device is a semiconductor-based electronic component that functions as a small heat pump. By applying a low voltage DC power source to a cooler, heat will be moved through the module from one side to the other. One module face, therefore, will be cooled while the opposite face simultaneously is heated. The task context immersed students in the context of providing evidence and justifications for temperature change using general principles in thermodynamics. Several lines of analyses have been conducted. First, the epistemic levels of students' arguments have been analysed based on a scheme concentrating on data representation, relational aspects of the Peltier effect, links between theory and data, and appeals to general laws of thermodynamics. Second, detailed analyses of students' arguments have been investigated for a set of case studies of students using Toulmin's Argument Pattern as an analytical framework. The results detail the correlations between the epistemic levels and quality of arguments produced.

S5.13.4 School Scientific Argumentation and the Cognitive Model of School Science

Mercè Izquierdo Aymerich, Universitat Autònoma de Barcelona, Spain

This interactive poster paper is devoted to discussing the role of what I call 'school scientific argumentation' in a cognitive model of school science, i.e., a way of designing science classes that is inspired in the model-based view of the philosophy of science.

S5.13.5 School Scientific Argumentation: Epistemic Components in Teachers' Written Productions

Adrianna Gómez, Unidad Monterrey-Cinvestav, Mexico
Patricia Iglesia, Universidad de Buenos Aires, Argentina
Ana Couló, Universidad de Buenos Aires, Argentina

We assume as a 'working hypothesis' that good school scientific argumentations have four components: logical (syntax), theoretical (model), pragmatic (adequacy) and rhetorical (pesuasion). In this poster paper we inspect how prospective science teachers use such components when constructing argumentations in their pre-service education.

S5.13.6 The Place of Argumentation in Undergraduate Chemistry Teaching

Salete Linhares Queiroz, Universidade de São Paulo, Brasil
Luciana Passos Sá, Universidade de São Paulo, Brasil

The purpose of this paper is to investigate to what extent argumentation activities are used in undergraduate chemistry teaching. Thirty five undergraduate chemistry lessons in a chemistry university course were systematically observed to conduct a pilot study. An observation schedule was used to record students activities and students-professors interactions. The findings indicated that in the majority of the classes it was the professor who did the talking and structured the arguments. The laboratory classes were organized in such a way that the students focused mainly on procedural aspects of the practical work. In order to understand the lack of argumentation activities in university chemistry classroom, the eight professors who taught the observed lessons were interviewed. The interviews indicated that there is a general lack of pedagogical expertise among professors in organizing activities in which students are given a voice.

S5.13.7 Argumentation, Authorship and Genre in Texts from a Teacher Education Journal

Isabel Martins, Universidade Federal do Rio de Janeiro, Brasil

In this paper we analyze argumentation patterns present in a set of texts that were published in an electronic Brazilian science teacher education journal (www.cienciaemtela.nutes.ufrj.br). As the texts differ with respect to genre and characteristics of authorship, our corpus involves articles, essays and reports written by scientists, science education researchers, schoolteachers, popular science professionals and educators from non-formal institutions. Based upon a theoretical framework that emphasizes the historical and social character of discursive production, our analyses selected genre and socio-conceptual horizon as main analytical categories. Argumentation patterns were then characterized as in terms of relationships between utterance patterns and features of the social activities and discursive practices they relate to. Texts were initially analyzed with respect to (a) their discursive intention, compositional structure and style and (b) the presence of discursive markers related to different social languages and conceptual horizons. We also sought for relationships between to evidence of relationships between genre and the authors' socio-conceptual horizons in terms of their choices for theme. Analyses show that several texts share thematic choices and adopt a stance in which teachers' autonomy is valued. Evidences of authors' different socio-conceptual perspectives are more clearly revealed by features in style and compositional structure of texts. For instance, issues of authority are revealed by the status given to methodological considerations, by the ways through which citations are incorporated in the literature reviews and by the description of what counts as a result. Finally, through the examination of the patterns of argumentation more typically present in the texts, we discuss obstacles to as well as possibilities of dialogue and mutual appreciation of contributions made by different author profiles.

S5.13.8 Argumentation as Epistemic Practice in the Context of Socioscientific Issues

Troy D. Sadler, University of Florida

This paper and associated poster will explore epistemic practices associated with the negotiation of complex, scientifically-based, social issues (i.e., socioscientific issues; SSI). The paper adopts a situated perspective on knowing and learning and positions public discourse and debate associated with SSI as an important manifestation of science in the lived experiences of students and other citizens in modern societies. Aspects of argumentation including, but not necessarily limited to, weighing evidence, drawing connections between data and claims, responding to counter-evidence, and offering well-reasoned rebuttals are central epistemic practices associated with public discourse associated with the negotiation of SSI. This paper will argue that these practices in the context of SSI ought to be featured elements of science education and will offer suggestions regarding how these goals might be accomplished in modern classrooms.

S5.13.9 Argumentation and the Nature of Science

Gábor Zemplén, Budapest University of Technology and Economics, Hungary

In this poster paper, several possible relationships between the nature of science and argumentation practices are discussed.

S5.14 Strand 14—SC-Paper Set: Teachers Impact on Environmental Education

S5.14.1 Investigating Rural Kenyan Teachers' Conceptions of Snakes: Alternative Perspectives for Teaching

David Wojnowski, University of North Texas

Investigating Rural Kenyan Teachers' Conceptions of Snakes: Alternative Perspectives for Teaching A 3-month qualitative study was conducted mid-September through mid-December 2005 to investigate rural southeast Kenyan teachers' conceptions of snakes. 60 teachers from 5 villages near Mt. Kasigau were interviewed about their conceptions of snakes to obtain baseline data before and after a herpetofauna institute. 28 of those teachers attended a 6-hour seminar on reptiles and amphibians. From these 28 teachers, 7 teachers from three villages were afforded additional educational opportunities about snakes, and 2 teachers from this group of 7 were teamed with 2 herpetologists as mentors. Observations of teacher participants during workshops and field outings were documented as well as teacher classroom pedagogy involving snakes before, during, and after the institute. Semi-structured and open-ended interviews were conducted with the eight core teacher participants and field notes were used to document participant observations during serendipitous live snake encounters, of which, there were many. Findings suggest that teachers' conceptions of snakes, within a culture where all snakes are feared and killed onsite, can change toward a more favorable orientation when faced with a scientific perspective of snakes.

S5.14.2 Case Studies of Participatory Action Research using the Place-Based Learning and Constructivist Environment Survey (PLACES)

David B. Zandvliet, Simon Fraser University
Marlene Nelson, Simon Fraser University

Preliminary studies at the intersection of environmental education and learning environments research have noted that in some cases, students' perceptions of preferred and actual learning environments have a much closer fit in interdisciplinary, experientially-based settings than in traditional classrooms. These earlier findings spurred the development of a more robust instrument for use in a variety of environmental education settings. This paper reports on qualitative case studies using a specialised learning environment instrument: the Place- based Learning and Constructivist Environment Survey (or PLACES). The findings from this study confirm the reliability and validity of the new instrument for assessing environments in a variety of contexts including elementary, secondary settings and has further enabled many forms of participatory action research involving teachers and informal educators.

S5.14.3 Investigating Preservice Teachers' Environmental Literacy through their Epistemological Beliefs

Gokhan Ozturk, Middle East Technical University
Ozgul Yilmaz Tuzun, Middle East Technical University
Gaye Teksoz Tuncer, Middle East Technical University

People's understanding about a scientific topic is related to their point of view about knowledge, in other words, their epistemological beliefs (Kardash & Scholes, 1996; Schommer, Crouse, & Rhodes, 1992). Therefore, it is required to investigate the effects of people's epistemological beliefs on their attitude and behavior about the environmental issues. Teachers play central role in attaining the goals of the environmental education and have multiplier effects on future generations' awareness, thus, the aim of this study was to find relationships between preservice teachers' (PTs) environmental behavior and their epistemological beliefs. The instruments to be used for detecting PTs is, Environmental Literature Test, developed by National Environmental Education and Training Foundation (NEETF & Roper, 2005), and that for detecting epistemological beliefs is the Schommer's (1990) questionnaire on the Epistemological beliefs. Sample of this study constituted 560 PTs from of a university. Multiple Regression analysis results indicated that for environmental behavior mean scores, three of the predictors - attitude, concern and innate ability- contributed significantly to the model. These three factors explained the 32, 6 % of the variability in the environmental behavior mean scores (adjusted $R2 = 0,326$, $F (3, 553) =90,081$, $p < .00$).

S5.14.4 Teacher Engagement in Climate Change Education

Joan M. Chambers, Lakehead University

This paper is intended to engender thought amongst educators and academics concerned about science education and the teaching of complex, socioscientific and environmental issues, specifically, climate change. The inclusion of socioscientific and environmental issues in the science classroom is an important component of science education; particularly in relation to the goal of helping students become scientifically and ecologically literate citizens able to participate fully in a democratic, sustainable society. However, complex socioscientific and environmental issues, such as climate change, are pedagogically challenging for science teachers and difficult to integrate into the science classroom. Typically, school science centres on accepted, consensual science; controversial socioscientific and environmental issues stem from frontier science and as such, are innately more tentative and uncertain. Teaching about climate change requires an interdisciplinary approach—it is an integration of scientific, social, economic, and political issues. This paper reports on research which investigates teachers' experiences as they engage in the pedagogy of socioscientific and environmental issues in their high school science classrooms. Specifically, this piece examines the challenges of interdisciplinary teaching about climate change. Framed within a phenomenographic research perspective, the study design includes both interview and classroom observation data.

PL. 2 Plenary Session—Grand Challenges in Science Education: What's Foundational for Science Learning?

Leona Schauble, Vanderbilt University

Dr. Schauble is a noted developmental psychologist who with her research colleague Richard Lehrer have been advancing new ideas and perspectives about both the content and sequence of K-8 science education.

S6.1 Presidential Invited Session—NARST's Grand Challenges and Great Opportunities: Presidential Speech Reaction Panel

Sandra Abell, University of Missouri
Charles Andy Anderson, Michigan State University
Jane Butler Kahle, Miami University, Ohio
Angela Calabrese Barton, Michigan State University
Audrey Champagne, SUNY at Albany
Penny Gilmer, Florida State University
William G. Holliday, University of Maryland
Joseph Krajcik, University of Michigan
Julie Luft, Arizona State University
Felicia Moore, Columbia University
Leonie Rennie, Curtin University, Australia
Dana Zeidler, University of South Florida

This panel of established and well known NARST members will give a thoughtful reaction to the presidential speech on Grand Challenges and Great Opportunities. Discussion and debate of further directions NARST might take to address the pressing challenges or our time in science education will also take place.

S6.2 Strand 1—SC-Paper Set: Informal Reasoning, Argumentation, and Metacognition

S6.2.1 An Investigation into the Relative Effects of Inquiry-Based and Commonplace Science Teaching on Students' Knowledge, Reasoning and Argumentation: A Randomized Control Trial

Christopher D. Wilson, BSCS Center for Research and Evaluation
Joseph A. Taylor, BSCS Center for Research and Evaluation
Susan M. Kowalski, BSCS Center for Research and Evaluation

Inquiry has been a prominent theme in multiple science education reform movements, yet the transition from theory and advocacy to practice and policy has been disappointing. Despite recent challenges, there is a growing body of research which suggests that student understanding is enhanced by inquiry-based teaching, but only recently have studies begun to use experimental designs – designs which are advocated in the current climate of accountability and evidence-based reform. We conducted a randomized control trial in which students received instruction either through an inquiry-based approach or via commonplace teaching strategies, as defined by Horizon

Inc. survey and interview data. Three different outcomes were measured: scientific knowledge; reasoning with scientific models; and construction/critique of scientific explanations. Students in the inquiry-based group scored significantly higher on a posttest measuring scientific knowledge and reasoning than students in the commonplace group, and also received significantly higher argumentation scores on posttest interviews. While no achievement gaps were present for race, gender or SES variables in the inquiry-based group, the commonplace teaching led to a significant achievement gap by race on posttests. The findings are discussed in the contexts of accountability and teacher practice, equitable science education, and the role of curriculum materials in reform.

S6.2.2 The Effects of On-Line Searching Activities on High School Students' Informal Reasoning on a Socio-Scientific Issue

Ying-Tien Wu, National Taichung University, Taiwan
Chin-Chung Tsai, National Taiwan University of Science and Technology

This study explored the effects of different on-line searching activities on high school students' searching outcomes, cognitive structures, and informal reasoning regarding a socio- scientific issue. In this study, thirty-three students were assigned to a "guided searching task group ", while thirty-five students were assigned to an "un-guided searching task group ". During the period of two classes (100 minutes), the students in the un-guided searching task group were asked to search relevant information regarding nuclear power usage freely, while those in the guided searching task group searched with a guideline. This study revealed that the two groups of students did not show any significant difference on their searching outcomes. Moreover, the students in the guided searching task group obtained significantly better cognitive learning outcomes; however, it was also found that the increments on their cognitive structure outcomes only help them to propose more arguments, but their rebuttal construction was not particularly improved. The findings of this study suggests that how to improve learners' better use of the information they have searched on the Internet in dealing with socio-scientific issues they encounter should be highlighted by researchers in science education.

S6.2.3 What Makes a Scientific Argument Persuasive? How Middle and High School Students View Different Types of Arguments

Jonathon Grooms, The Florida State University
Victor Sampson, The Florida State University
Leeanne Gross, The Florida State University

Presenting a logical and coherent scientific argument is essential in progressing the body of scientific knowledge. Scientific arguments seek to persuade through the use of carefully collected data and constructed evidence. Students are often presented with materials designed to alter the way they think, or persuade them, on a daily basis, including in the science classroom. Because of the importance of argumentation in science it is necessary to know what students find persuasive. This study examines what types of arguments middle and high school students find persuasive and the criteria used for making such judgments. After quantitative and qualitative evaluation of our data we determined that the middle and high school students (N=109) participating in this study found empirical based arguments more persuasive than arguments relying on inferences or authority to support a claim. There were also three main criteria that the students used for determining an arguments persuasiveness: 1) Inclusion of "facts" and providing an explanation of the facts; 2) Plausibility of the justification, and 3) The credibility of the information included in the argument. These results are further discussed as well as the implications for science educators.

S6.2.4 The use of Metacognition during Error Correction by High School Physics Students – An Exploration

Kathy L. Malone, Shady Side Academy, PA

This verbal protocol study was designed to allow for an analysis of the metacognitive tasks conducted by high school physics students before, during and after an error correction episode while solving physics problems. Participants solved five detailed physics problems in a talk aloud fashion. The transcripts were analyzed to determine when students produced errors and if the errors were caught. These error sections were analyzed in detail to determine what type of metacognitive task the students used before they caught the error, while correcting the error and after they corrected the error to determine if there was a difference in the type of metacognitive task used specifically planning, monitoring comprehension and evaluating. It was discovered that there is a definite shift in the type of evaluation tasks students conduct before the students make an error, during the correction of the error and after the error is corrected. By understanding the metacognitive and problem-analysis activities occurring during an error correction episode teachers' can better scaffold these tasks so that students can become better at revising errors.

S6.3 Strand 1—Related Paper Set: Young Children's Conceptions of the Moon

S6.3.1 Children's Stories and Ideas about the Moon

Robert D. Louisell, St. Ambrose University
Francis E. Kazemek, St. Cloud State University
Jerry Wellik, St. Cloud State University

We explored how children develop their understanding of the natural world through cognitive development as well as through the stories and experiences of their culture. When children revert to their naive conceptions from more schooled ones, are their ideas influenced by "spontaneous" thinking or by cultural influences? Triangulation of multiple researchers, data sources, and theories-especially those which have roots in Vygotsky or Piaget--were utilized for the early stages of this study. We conducted a Piagetian interview with each child and followed by having the child tell a story about the topic of the interview. Finally, we interviewed the child's parents--and sometimes, teachers--to determine possible influences on the child's ideas. Stories were important because of their narrative--as opposed to paradigmatic--nature, and were analyzed for developmental complexity. Findings reflected the complex relationship of individual to culture in the child's construction of ideas. Implications included: Parents should be interviewed in order to give a richer picture of the child's thinking, children's stories should be studied in order to assess the complexity of the child's rendering abilities, and researchers must persistently sleuth out those cultural artifacts that influence the child as she develops her ideas.

S6.3.2 A Case Study of Three Children's Original Interpretations of the Moon's Changing Appearance

Jennifer A. Wilhelm, Texas Tech University

A case study of three children was conducted to shed light on the process that children undergo in developing their understanding of physical phenomena. Using the notion of spontaneous construction and its relationship with school learning of scientific concepts, children's early thoughts of the moon's appearance were explored. Research questions were primarily concerned with how children view the moon's appearance, explain how and/or why its appearance changes, quantify the moon's size and its distance to Earth, and explain the moon's illumination. A modified Piagetian interview was conducted with each child and then each was asked to tell a story about the moon. The external interest of this research study involves when and why do children develop the commonly held Earth's shadow alternative conception as the cause of the moon's phases. The findings show that children have stories and experiences that give meaning to the existence of such things as the moon, stars, sun, and clouds. Similarities were found in the children's interpretations with regard to their natural tendencies to animate celestial objects. Clues were discovered of cultural influence such as family, personal observations and experiences, books, pictures, and even a strategically placed Palladian window.

S6.3.3 A Sociocultural Perspective on Young Children's Conceptions of the Moon

Grady J. Venville, University of Western Australia

In-depth case studies of two children (5 and 6 years old) were conducted to shed light on the sociocultural factors that influence children's developing understandings of the moon. A modified Piagetian interview was conducted with the two children and then each child was asked to tell a story about the topic of the interview. Finally, each child's parents were interviewed to determine possible social and cultural influences on the child's conceptions. Findings reflected the complex relationship between the way that children construct ideas and their social and cultural experiences. Five themes emerged from the data including: 1. The moon, rockets and astronauts; 2. The non-living moon; 3. Movement of the moon; 4. The yellow moon; and, 5. Views from the moon. Each theme is discussed and evidence about social and cultural factors that impacted on the children's understandings related to the theme are presented. The findings suggest a new sociocultural typology of conceptions including conceptions that are influenced by universal experiences, conceptions that are influenced by common cultural and social experiences, and conceptions that are influenced by experiences idiosyncratic to the individual.

S6.3.4 Young Children's Conceptual Universtanding about the Moon Before and After an Inquiry-Based, Technology-enhanced Experience

Sally M. Hobson, The Ohio State University
Kathy Cabe Trundle, The Ohio State University
Mesut Sackes, The Ohio State University

This study explored young children's understandings of targeted lunar concepts, including when the moon can be observed, observable lunar phase shapes, predictable lunar patterns, and the cause of lunar phases. Twenty-one children (ages seven to nine years) from a

multi-aged classroom participated in this study. Data were collected using semi-structured interviews, student drawings, and card sorting before and after an inquiry-based, technology-enhanced instructional intervention. Students' lunar calendars, written responses, field notes, and videotaped class sessions also provided data throughout the study. Data were analyzed using codes from prior lunar studies and constant comparative analysis. The instructional intervention included lunar data gathering, recording, and sharing, integrating Starry Night planetarium software and an inquiry-based instruction on moon phases (McDermott, 1996). Through a guided inquiry context children worked in groups to gather and analyze nine weeks of lunar data. Findings reflected a positive change in student understanding of all targeted concepts. After the intervention more children understood that the moon could be observed sometimes during the day, more children drew scientific moon phase shapes, and more children drew scientific representation of the moon phase sequences. Also, more children understood the cause of moon phases.

S6.4 Strand 2—SC-Paper Set: Fostering Collective Responsibility in Science Education across Gender and Other Social Boundaries

S6.4.1 Freshmen Students' Chemistry Self-Efficacy in Relation to Goal Orientation, Gender, and Academic Achievement

Betul Demirdogen, Zonguldak Karaelmas University
Esen Uzuntiryaki, Middle East Technical University
Yesim Capa Aydin, Middle East Technical University

The present study aimed to investigate the contribution of college students' goal orientation (intrinsic and extrinsic), gender, and academic achievement to their chemistry self-efficacy beliefs. Data were collected from 410 college students using motivated strategies for learning questionnaire and college chemistry self-efficacy scale (CCSS). Simultaneous multiple regression analyses were performed using three subscales of the CCSS as the criterion variables. Findings indicated that intrinsic goal orientation was the only predictor for chemistry self-efficacy. Implications and suggestions for further research are provided.

S6.4.2 Data Logging in Senior High Science: Are we Disadvantaging Females?

Ronald J. MacDonald, University of Prince Edward Island
Angela F. Larter, University of Prince Edward Island
Jeff Carragher, Eastern School District
Chris Higginbotham, Western School Board
Lisa Ling, Eastern School District
Ryan McAleer, Western School Board
Dave Ramsay, Western School Board
Steven Wynne, Eastern School District

Gender gaps in attitudes and self-efficacy beliefs still exist in K-12 and post-secondary education, which may affect female's decisions to choose and persist in physical science related academic programs or careers. It has been reported that creating opportunities for students to engage in active learning, like student inquiry, may improve attitudes and self- efficacy, which may reduce gender gaps. Hand-held data loggers (with their own screen, and have the ability to attach sensors like motion and pH) can help students inquire. This mixed- method study of 300 grade 10 science and grade 11 physics students from 10 teachers' classrooms in Prince Edward Island, Canada, sought to find if student inquiry, aided by hand- held data loggers, helps reduce attitudinal and self-efficacy gender gaps. Technologies, like data loggers, are continually being introduced into the classroom context. It is crucial that we find out how these technologies affect both males and females. Could we be disadvantaging females through the integration of these devices? Findings suggest that important gender differences persist between male and females (like science anxiety and self-confidence in the ability to learn science). Implications for teacher practice and future research are proposed.

S6.4.3 The Differential Role of "The Message" and "The Messenger" in the Learning Process

Meena M. Balgopal, Colorado State University

It is accepted by science education researchers that motivation to question personal conceptions is a precursor for conceptual change. The objective of this naturalistic study was to identify factors that influenced college zoology students' motivation to identify and resolve their misconceptions about evolution. This study was grounded in Symbolic Interaction and Socio-cultural theories which both support the notion that learning is a social process and that dialogic interactions shape people's motivation to learn. Learners were enrolled in an upper division ecology course in which the researcher was a participant observer. Nineteen students volunteered to be research subjects, and six of these students improved markedly (+20%) on their posttests. Using a constant comparative method analyzing multiple sources of data (pre/posttests, reflective essays, semi-structured interviews, and classroom observations) it was found that these six learners' motivation to resolve their confusion was influenced by their acceptance of the instructor (messenger), their acceptance of evolution (message), or the combination of these two. The six learners were classified into three categories of acceptance: unconditional, passive, and ambivalent. The implications of this study are important, for they highlight the importance of learner-instructor relationship in the learning process.

S6.4.4 The Organic Chemistry Workshop: Fostering Individual & Collective Responsibility for Learning

Karen E. S. Phillips, Hunter College of CUNY

Organic Chemistry is regarded as one of the most difficult courses in the undergraduate curriculum. It is also a "gatekeeper" course that students must complete before progressing toward their chosen careers in the health professions or most other scientific fields. The subject demands a high level of abstract and analytical thinking as well as visualization in three-dimensions, and its concepts are expressed in what, for most students, might seem like an entirely new language. Consequently, those unaccustomed to this type of thinking often embark on an Organic Chemistry course with the mindset that it will be extremely difficult in comparison to other classes they will encounter during their undergraduate years, creating a level of fear that can be paralyzing to student learning. This study focuses on a combined Lecture/Workshop model for Organic Chemistry instruction at a large and diverse urban institution. Data gathered from videotape of Workshop activities suggest that they bolster critical thinking skills among students and set the stage for an iterative cycle of increased engagement and self-confidence. Examination of evidence from video vignettes recorded in Workshop sessions show a progression from relative dependence on the instructor to greater collective engagement and responsibility for learning.

S6.5 Strand 2—Symposium: Quality of Instruction in Science Education

Birgit J. Neuhaus, University of Munich
Hans E. Fischer, University Duisburg-Essen
Angela Sandmann, University Duisburg-Essen
Elke Sumfleth, University Duisburg-Essen

There exists a huge number of studies on teachers' effectiveness as well as on quality of instruction (for reviews compare Fraser, 1987; Wang et al.1993). In our days this research is enriched through video-studies (compare e.g. TIMSS Video, 1997). Nevertheless, most of the studies on instruction quality focus on quality of instruction in general. Within this symposium we will focus on a science-specific view on quality of instruction. We will present six empirical studies on quality of instruction, two focusing mainly on biology education, one on chemistry education and three on physics education. At the beginning of the symposium the theoretical base and structure of the six studies will be presented through the organizers. Afterwards, each of the projects will be presented through a poster presentation.

S6.6 Strand 3—Strand Invited Symposium: The Importance of Elementary Science Education in the NCLB Era

Julie Gess-Newsome, Northern Arizona University
Reneé Schwartz, Western Michigan University
Deborah Hanuscin, University of Missouri
Joanne Olson, Iowa State University
Deborah Smith, Penn State University
Marian Pasquale, Education Development Center
Abigail Levy, Education Development Center

Since the No Child Left Behind Act (2001) mandated assessment of student knowledge of language arts and mathematics, science has been the step-child of elementary school curriculum in the United States. Research has shown that fewer instructional minutes are devoted to science than to language arts and math at the elementary level, even though student discourse during science investigations has been shown to promote language and cognitive development as well as mastery of science content knowledge. This symposium's panel of researchers have all recently been involved in studying delivery models for elementary science instruction and how children's ideas about science and scientific work develop over time. We believe this symposium would be of interest to NARST members who are actively working on conceptual and pedagogical content knowledge acquisition. This session also has policy implications locally, nationally, and internationally in terms of promoting science education at the elementary level as a foundation for later science study at the secondary and university levels and Federal and State allocation of funding for resources to teach science at the elementary level. There will be time allocated to discussion among the panel members and with the audience about research issues related to early science education.

S6.7 Strand 4—Related Paper Set: Teachers' Professional Knowledge for Integrating Nanoscience and Engineering into Middle School Science Curricula

S6.7.1 Overview of Teachers' Professional Knowledge for Integrating Nanoscience and Engineering into Middle and High School Science Curricula

Lynn A. Bryan, Purdue University

The field of nanoscience and engineering (NSE) represents both grand challenges and great opportunities for science education. It is a grand challenge in the sense that the integration of new and revolutionary science content into middle and high school science curricula is a complex task. With most science teachers believing that their curriculum is "a mile wide and an inch deep", a strong case must be made for why new content is important and how it connects to existing curricula. In addition, the interdisciplinary nature of NSE necessitates that teachers find creative ways to integrate traditionally demarcated disciplines that comprise the grade 7-12 science curriculum. Furthermore, teachers will need to develop new knowledge and skills for teaching NSE concepts in their classrooms. On the other hand, the field of NSE provides a grand opportunity to reform and extend school science as we currently know it into an exciting new scale. This paper set examines aspects of teachers' emerging professional knowledge related to NSE and implications for the integration of this new and emerging field of science into existing science curricula.

S6.7.2 Middle and High School Teachers' Development of Nanoscience and Engineering Subject Matter Knowledge

David Sederberg, Purdue University
Shanna Daly, Purdue University and University of Michigan
Lynn A. Bryan, Purdue University

The convergence of the traditional sciences by nanoscale science and engineering (NSE) into a whole science poses unprecedented challenges for educators. The knowledge and skills required to incorporate emerging science content such as nanoscience in the classroom require professional development. This study reports findings from year 3 of a professional development (PD) research agenda whose central goal is to facilitate grade 7-12 teachers' construction of NSE knowledge. An interdisciplinary team of scientists, engineers, science and engineering educators, assessment specialists, graduate students and "master teachers" collaborated in the design and implementation of a PD experience aimed at (a) providing grade 7-12 science teachers with an enhanced understanding of NSE; (b) enhancing teachers' understanding of the convergence between NSE and traditional sciences; and (c) enhancing teachers' knowledge and skills for using inquiry-based methods for teaching NSE. Specifically, the central guiding question for this study was: What is the nature of teachers' emerging conceptions of nanoscale phenomena after engaging in the PD experience. In this paper, we report findings from a study that examined teachers' emerging conceptions of nanoscience phenomena, including size and scale, structure of matter, size-dependent properties, forces and interactions, self-assembly, models and simulations, and tools/instrumentation. Implications for PD are discussed.

S6.7.3 Determining the Role of and Developing Instruction for Models in Nanoscale Science and Engineering Education

Shanna Daly, Purdue University and University of Michigan
Lynn A. Bryan, Purdue University

The use of physical representation models are especially important in nanoscale science and engineering education (NSEE), as nanoscale phenomena cannot be explored by students via photographs, light microscopes, or demonstrations; only the resulting micro- or macroscopic effects can be witnessed. Using models as tools for education, however, does not have to be restricted to visualization. As part of a three year investigation, we have identified a number of ways that models can be used in NSE instruction that provide learners with a variety of opportunities to work with models beyond visualization. They include critiquing models, using models as tools to investigate phenomena, and design physical representations to represent their conceptions. The translation or our ideas on the use of models in NSEE relies upon teachers. Thus, our research has also been focused on understanding what ideas teachers have about models and their use in instruction. In this paper we explore teachers' conceptions of the role and use of models and instruction that can facilitate teachers' effective utilization of models for NSEE. These investigations contribute to a broader project to understand the role and significance of models in NSEE.

S6.7.4 Where Does Nanoscience Fit? An Analysis of Middle and High School Science Teachers Nanoscience Lesson Plans

Emily Wischow, Purdue University
Lynn A. Bryan, Purdue University

As developments in nanoscience and engineering continue to influence technological developments in multiple science fields, research is needed to investigate how nanoscience content is being incorporated into secondary science classrooms. This study presents an analysis of teachers' nanoscience lesson plans designed during a professional development institute in summer 2008 focusing on nanoscience, engineering, and technology. Lessons developed during the institute were analyzed to answer the research questions: Where do teachers perceive the fit between traditional science courses and nanoscience content? and How did the lessons reflect the process of construct-centered design of lesson planning? A rubric was developed to analyze the lessons and refined through cycles of iteration, and investigated four major areas: lesson plan design, fit of nanoscience material within the larger curriculum, use of nanoscale content, and connection to state and national science learning standards. Demographic data is presented, as well as qualitative themes that emerged from the lesson plan analysis. The paper includes findings on how teachers connect nanoscience to societal impacts, as well as how they structure existing units around nanoscience lessons. This study has implications for future professional development in nanoscience education and implementation of other cutting-edge science into secondary classrooms.

S6.7.5 Mediators of Middle and High School Teachers' Integration of Nanoscale Science and Engineering Content into their Existing Curriculum

Kelly Hutchinson, Purdue University
Lynn A. Bryan, Purdue University
Shanna Daly, Purdue University and University of Michigan

Previous research on the implementation of innovative science curricula has indicated that teachers encounter numerous barriers in reforming existing curricula and integrating new content. These barriers include a lack of science equipment, insufficient support from a professional development team, lack of time to plan and teach the new lessons, inadequate knowledge of new content, and beliefs about the teaching and learning as well as the innovation to be implemented (Peers, Diezmann, Watters, 2003; Roehrig, Kruse, Kern, 2007). One innovative science discipline currently under investigation is nanoscale science and engineering (NSE) due to its emerging prominence in society and the need to help students in the job market and to become informed citizens. NSE content presents interesting challenges such as its interdisciplinary nature (vis-à-vis domain-specific content classes) in 7-12 classrooms. Hence, this study examined teachers' experiences integrating NSE into their existing physical science, physics, chemistry and biology curricula, and sought to find out: What factors mediate secondary teachers' integration of NSE into their existing curriculum? Additionally, we discuss how we have used our research to modify our PD instruction to support secondary science teachers' integration of NSE into their curricula.

S6.8 Strand 5—SC-Paper Set: Issues in Interdisciplinary Science

S6.8.1 Investigating Post-Secondary Students' Perceptions Of Temporal Scales Associated With Scientific Changes

Hee-Sun Lee, Tufts University
Charles A. Price, Tufts University

We investigated how post-secondary students perceive temporal scales associated with various types of scientific changes. We developed a survey where students chose a temporal category that matched the time needed for each of 36 scientifically-studied processes. We collected survey data from 411 students taught by 14 instructors from various post-secondary institutions. Results indicate that (1) students were more accurate within directly experiential ranges and less and less accurate towards extremely short and extremely long ranges and (2) the number of physics and chemistry courses taken at high school and college levels had a positive impact on student perceptions of temporal scales. We also found a significant gender effect favoring males on how accurately students perceived temporal scales. Further analysis indicated that, though both genders were comparable in perceiving too short temporal magnitudes, the gender difference increased as temporal magnitudes increased. Both genders were comparable in estimating time in artificial contexts, but the gender difference was significant in time estimations relating to trends, cycles, and evolutionary changes.

S6.8.2 Gender-Based Geospatial Differences in College Students

Iris Totten, Kansas State University
Juli Moore, Michigan State University

Gender based geospatial literacy differences were identified in 130 students at a mid-western university. Students from a cross-section of courses including freshmen introductory geoscience labs, undergraduate, and graduate geoscience courses were administered the following four instruments over a semester: the 1) Middle Grades Mathematics Project Spatial Visualization Test (MGMP-SVT), 2) the Group Assessment for Logical Testing (GALT), 3) a Prior Knowledge Survey (PKS), and 4) the Contour Map Memory Test (CMMT). Descriptive and comparative statistics were calculated using both SASS and SPSS. The MGMP-SVT showed a statistical difference based on a two-tailed t test (p=.0010), the GALT indicated (p= 0.1209) no statistical difference (p= 0.1209), the PKS and the CMMT indicated differences with a paired two-tailed t-test, P values at <.0001 and .0078, respectively. These findings indicate that males significantly outperformed females on the MGMP-SVT, the PKS, and the CMMT, while no significance was found between genders on the GALT. This suggests that genders reside in equivalent Piagetian stages of logical mental development although their spatial aptitudes show a significant gender gap. Differences in spatial literacy could be attributed to factors such as prior knowledge and/or classroom experience and not developmental logical aptitude.

S6.8.3 Using Concept Maps to Evaluate Conceptions of the Nature of Science among Prospective Elementary Teachers

Catherine S. Martin-Dunlop, California State University, Long Beach

In a course specifically designed for prospective elementary teachers, developing a concept map to show understanding of the nature of science (NOS) was part of a final assessment. Understanding the NOS was a major goal of the integrated science course in which a variety of implicit and explicit approaches to teaching and learning the NOS were used. Concept maps seem to be particularly effective in showing if students can synthesize and apply what they learn about the theoretical aspects of scientific research to a practical 'real life' study. Students' representations of NOS at the end of the 15-week course were scored using three different methods including Novak and Gowin's original scoring rubric, and then concept maps were grouped under various themes. Relationships between concept maps' structural complexity and levels of understanding of NOS were also investigated. Lastly, the various themes derived from collating the concept maps were described in more detail by expanding them into interpretive narratives.

S6.8.4 Implementation Study of a Novel Science Curriculum for First Year College Students "A Case Study of Columbia's Frontiers in Science."

Julia E. Sable, Columbia University

The purpose of this qualitative case study is to describe how a required novel science curriculum called the Frontiers of Science (FOS) was developed and implemented for the freshman population of Columbia University. FOS aims to make science a primary component of the core curriculum by providing students with collaborative and multi-disciplinary content areas where they are encouraged to debate and discuss the frontiers of science research. The course allows faculty to create a forum for open discourse among multiple content areas by centering lectures and activities around the scientific "Habits of the Mind". This study utilizes a Garbage Can Theory of Organizational Choice combined with Cognitive Apprenticeship to describe the critical decisions, actions and context that created FOS. Utilizing these theories, one finds that there are critical 'policy entrepreneurs' who navigated FOS from a loose set of ideas during the pilot phase to a permanent core-course; that 'problematic preferences' and 'fluid participation' between faculty from different disciplines and with varying levels of teaching experience attributed to a unique, reflective and flexible pedagogical method of science teaching; and that 'unclear technology' allowed faculty to integrate multiple scientific literacy and assessment strategies to meet the needs of a diverse student population.

S6.9 Strand 6—SC Paper Set: Challenges of Science Learning Across Multiple Contexts—Round Table Discussions

S6.9.1 Young Scientists at Summer Camp

Ann Sherman, University of Calgary
A. Leo MacDonald, St. Francis Xavier University

This article describes the experiences of young children (ages six and seven) in a summer chemistry camp. The purpose of the camp is to expose children to science activities that have them begin to talk, work and act like scientists, thus developing scientific literacy. Throughout the camp activities, the children were encouraged to use their skills of observation, record keeping and to use scientific language. Individual students were interviewed near the end of the camp about their camp experiences. Children were also shown photographs of some of the activities they had participated in as a way of prompting their explanations and conversation. The interview questions focused on students' scientific knowledge and literacy and general attitudes towards science. The children's responses to interview questions were analyzed and categorized into three main theme areas: 1) their science discourse, 2) demonstration of content knowledge, 3) enculturation into science. The children utilized correct terminology and described all steps required to complete each experiment. This showed children's attention to detail, likely due to their interest in the experiments and the emphasis placed on careful observation and record taking.

S6.9.2 Science Center Program Development for Schools: Challenges and Opportunities

Patricia M. Rowell, University of Alberta

Many science centers offer programs designed specifically for schools, programs which are not open to the public. As part of a larger study, this report examines the work of science center educators in developing such programs by addressing the research question: How, and by whom are programs for schools developed? Data sources are audio-taped interviews with 18 program developers at 10 urban science centers (including a zoo, aquarium, botanical gardens and museums). Drawing on Engeström's model of activity systems, the data have been analyzed to recognize the contradictions facing educators. These include the linking of programs to the formal school curriculum, the placing of school programs in science center locations, and the theoretical framing of programs for schools. The study points to opportunities which may result from recognition of these contradictions.

S6.9.3 Learning and Becoming across Time and Space: Insights from a Fire Ecology Project and a Garden Program

Jrène Rahm, Université de Montréal, Canada
Allison J. Gonsalves, McGill University, Canada
John C. Moore, Colorado State University

How time organizes learning has received little attention in the science education literature despite its salient role. Once the timescale expands, the spatial scale does too, and learning has to be understood as interspatially defined. Through two case studies, we explore these dimensions of learning and becoming in science outside of school, in the context of a fire ecology project that resembles network science projects, and a garden program. We show how diverse youths' observations of re-growth contributed to their complex visions of science and nature. We also illustrate how engagement in gardening over time supported the integration of diverse ways of knowing and becoming that were spatially marked initially. We conclude with some suggestions about ways attention to time and space offer a means to move beyond the dichotomy between formal and informal learning that has become a hurdle for understanding the grand challenges yet also great opportunities of science literacy development.

S6.9.4 Outdoor Learning in the Rainforest: Addressing Students' Questions and their (Mis)conceptions through Experiential Learning

Christine Chin, Nanyang Technological University, Singapore
Tayeb bin Rajib, St Stephens School, Singapore

Urban students who live in cities seldom experience the rural outdoors when learning science. This lack of first-hand experience with nature is of concern, especially when they are learning about animals, plants, and ecosystems. The purpose of this study was to investigate how an elementary school teacher tried to "teach less" and let his students "learn more" by organizing an inquiry-based field trip to the rainforest. This was done with the aim of helping the students to bridge the gap between what they learned theoretically from school and experientially from the natural environment. Prior to the field trip, the teacher first identified students' ideas about tropical forests, including their misconceptions, via a questionnaire and interview. Students also posed questions regarding what they wanted to know about rainforests. Based on this formative feedback, the teacher then designed investigative activities that revolved around students' questions and that addressed their pre- conceived ideas. The study's findings underscore the importance of taking students on field trips outdoors when teaching about the natural environment. We also suggest a "bottom-up" approach to lesson design that takes into account students' prior ideas, and that accords importance to the role played by students' questions.

S6.9.5 Understanding Emergent Challenges and Adaptations in the Design of an OST STEM Project through a Structure, Behavior and Function (SBF) Complexity Lens

Susan Yoon, University of Pennsylvania
Melissa Chessler, University of Pennsylvania
Rashmi Kumar, University of Pennsylvania
Darryl Williams, University of Pennsylvania
Jacqueline Flicker, University of Pennsylvania
Sandra Dunham, University of Pennsylvania

In this paper we outline the first phase of a two phase study that aims at describing an analytical framework that can account for the multiple components necessary for consideration in sustaining and scaling an OST STEM project. We are responding to the calls for research specifically in informal settings to use creative design and analytical approaches (Rennie et al. 2003) and generally for educational reform to use methodologies that account for the multidimensional, nested and complex nature of education systems (Coburn, 2003; Elmore 1996). Through using an structure, behavior, and function (SBF) framework to categorize emergent themes in the data collection, and by prioritizing design adaptations that potentially have high systemic impact, we demonstrate a complex approach to designing, sustaining, and scaling OST STEM programs.

S6.9.6 Informal Learning in Formal Settings

Janette Griffin, University of Technology, Australia
Peter Aubusson, University of Technology, Australia

There has been considerable study into the nature of informal science learning in settings such as museums and science centres. There have also been studies into the learning approaches used by teachers in both formal and informal settings. This presentation will explore the outcomes of a project in which students were able to use an array of informal learning approaches within a formal school setting. Students chose an object or technology that is used today and traced the changes in the inherent science and technology over time. The students worked in small self-selected groups with support from teachers and presented their findings in 'museum' displays. Data on the effectiveness of the project were collected through interviews, conversations and focus groups with teachers and students. Students enjoyed the experience, were very proud of their display and were keen to tell others what they had learnt. The aspects that underpinned the success were: allowing students to determine their own group and their own topic; starting from where they were at; collaboration, choice and control; teachers providing support without directing; a final display allowed an opportunity to share what they had learnt, and to learn from others.

S6.10 Strand 7—SC-Paper Set: The Role of Field Experiences in Preservice Teachers' Development

S6.10.1 Out in the Field: Evaluating Elementary Science Teacher Efficacy and Elementary Teacher Efficacy in Preservice Elementary Teachers

Ron R. Wagler, University of Texas at El Paso

The purpose of this study was to investigate the impact of preservice teacher field experiences on preservice science teacher efficacy and preservice teacher efficacy. The participants for the study were 46 preservice elementary education students enrolled in an educational field experience course and 20 inservice teachers. A pretest was administered early in the semester, before the preservice teachers did their field experience and consisted of demographic questions and the STEBI-B. A posttest was administered at the end of the semester, after the preservice teachers had completed their field experiences, and consisted of demographic questions, a rating of the teachers they observed during their educational field experience, the STEBI-B and the TES. The field experience classroom inservice teachers provided personal, professional, and classroom data during the semester. All data were analyzed using ANOVA and ANCOVA. Variables of gender, ethnicity, socioeconomic status and preservice teacher program placement were significant predictors of preservice teachers' efficacy. Even though, in some cases, these variables negatively impacted preservice teacher efficacy, preservice teachers should be placed in these environments when support is most available. The reliability of the Teacher Efficacy Scale (Gibson & Dembo, 1984) is debatable. Even the construct of a general teacher efficacy is questionable.

S6.10.2 Concept Map Assessment of Preservice Teachers' Increased Science Content Knowledge as the Result of One-to-One Clinical Field Experiences

Julie Thomas, Oklahoma State University
Ratna Narayan, Texas Tech University

Earlier research on unique, one-to-one field experiences (where elementary preservice teachers designed and presented science lessons to match the conceptual learning needs of one elementary student) found that preservice teachers largely attributed their increased science confidence and enthusiasm to their one-to-one clinical field experiences with children. These studies, of the ways in which children influenced preservice teachers' new awareness of science, relied on qualitative data analysis of participants' transcribed interviews, lesson plans, and personal reflections; final exam papers; and focus group interviews to gather detailed data about participants' clinical field interactions with children. The current study seeks to measure elementary preservice teachers' increased science content knowledge as the result of one-to-one paired interview teach sessions in clinical field experiences. Participating preservice teachers completed concept maps pre- and post- field experiences in which preservice teachers, paired one-to-one with a 5th grader, prepared and taught lessons on adaptation. A paired samples t-test found a significant difference [$t(19) = - 2.808$, $p = .011$, □ $= .05$] between the pre-test scores and the post-test scores. The post-test scores were significantly higher than the pre-test scores. Results imply one-to-one clinical field experiences can have a significant impact on prospective elementary teachers' content knowledge.

S6.10.3 Pre-Service Science Teachers' Reflections upon their Micro-teaching Experience: An Activity Theory Perspective

Asli Sezen, Pennsylvania State University
Minh-Dan T. Tran, Pennsylvania State University
Scott P. McDonald, Pennsylvania State University
Gregory J. Kelly, Pennsylvania State University

The study draws from cultural-historical-activity-theory (CHAT) and sociolinguistics to analyze the pre-service teachers' reflections on a micro-teaching activity. The study was conducted with 23 pre-service teachers enrolled in a secondary science teaching methods course at a large university's teacher education program. During this course, pre-service teachers' engage in micro-teaching of 4-5 middle school students. These events were videotaped, and the teachers subsequently provided voice-over reflections on a second audio track of videotapes. Transcriptions of the micro-teaching events were analyzed through the formation of event maps showing the phases of activity and the organizational sequence of actions. Event maps were used to investigate the focus of pre-service teachers' reflections. A categorical analysis was also implemented to analyze transcripts of reflections. Our analyses of the discourse of the teaching events and voice-over reflection generated 9 different subjects of observation and 42 topics of observation that can be related to science, observations about students and teachers as learners as well as student and teacher actions. The results show the early development of learning to be a reflective teacher and the potential of CHAT to contribute to the understanding of the discourse of learning to teach.

S6.10.4 Yearlong Internship Program for Qualified STEM Teachers K-12

Shirley Zongker, UMBC
Anne Spence, UMBC
Teresa Irish, UMBC

This research presentation will describe a unique pre-service program which prepares new teachers with strong STEM backgrounds to work in high needs schools. These interns take the required thirty-six credit Master program while interning for one full school year with a tenured, professionally certified classroom teacher. Levels of support to the interns come from a variety of sources which include: the lead teacher (mentor), university liaison (supervisor), school-based liaison, the program coordinator, and through cohort activities. Research for this study utilizes a mixed methods approach involving data from the program database, focus groups, surveys, and evaluations. This study will analyze the components to determine which contribute the most to the success of the internship in terms of producing highly qualified teachers.

S6.10.5 Constraints and Choice: The Field Experience of a Science Education Researcher

Selcen Guzey, University of Minnesota
Anne Kern, University of Idaho

This study examines the field experience of a pre-service science teacher. The researchers followed the pre-service science teacher/

researcher, Brenna, into her year-long field experience, both early field experience (practicum) and student teaching experience. During the time of the study, Brenna was also working as a researcher on a large scale longitudinal research study that focused on the impact of teacher induction on beginning science teachers' practices. To investigate the complexities of her field experiences, the researchers used a wide variety of data collection methods: interviews, surveys, classroom observations, and Brenna's audio journal. The data were analyzed using phenomenological framework. The results indicated that the varied experiences that Brenna had in working first hand during an active research project on teaching and learning in science contributed to her growth and development as a pre-service science teacher. In addition, the findings of this study showed the importance of building a professional learning community including the student teacher, the university supervisor, and the cooperating teacher to promote the student teachers' performance. Finally, it was found that teacher education programs should consider extending field programs and offer pre-service teachers opportunities to analyze their practices and develop their skills and abilities about teaching and learning.

S6.11 Strand 8—Symposium: Exploring Pathways for Science Teacher Transformation: Evidence for the Role of Context, Community, and Identity

Gail Richmond, Michigan State University
Cynthia Passmore, University of California, Davis
Kathleen Roth, LessonLab Research Institute
Viola Manokore, Michigan State University
Daniel Birmingham, Michigan State University
Lin Xiang, University of California, Davis
Connie Hvidsten, University of California, Davis
Richard Hedman, California State University, Sacramento

It is widely recognized that for students to achieve the level of understanding advocated for in recent reform initiatives, the teaching of science must undergo a radical shift. This session brings together two large-scale professional development projects that have been focused on the reform of elementary and secondary science teaching. One of these projects has at its heart the use of model-based reasoning as a foundation for successful science teaching and learning; the other project has been centered on the principles guiding the development and maintenance of effective communities of practice, particularly in urban contexts. Our research shows that three things seem to be key in the change process for teachers: community, context, and identity. We present empirical findings related to these three features of professional development and then propose three design principles that can guide professional development. One of our goals in offering this symposium is to invite participation and varying perspectives from those who have been engaged in sustained professional development efforts with teachers and to promote ongoing interactions and collaborations and offer a set of empirically based design principles that can serve as a foundation for future professional development efforts.

S6.12 Strand 8—Related Paper Set: Charting New Territory: The Learning of Early Career Science Teachers

S6.12.1 Bringing Content into Induction Programs: Overlooked, but Necessary

Julie Luft, Arizona State University

The content knowledge a teacher holds is important as instructional decisions are made that impact student learning. In order to support teachers in the development of their content knowledge, initial certification programs and professional development programs are enacted that focus on helping teachers translate content knowledge into classroom practice. Unfortunately, this has not been the case with induction programs. As a result, the most difficult time in a teacher's career, a period of time in which the beginning teacher needs to draw upon and utilize instruction strategies in a content area, a new teacher is given access to general assistance that emphasizes management over content. This paper suggests that content is important to consider during an induction program, and that just assigning a content mentor is not enough. Induction programs should emphasize the teaching of content in the same manner as initial certification and professional development programs. This paper elaborates on the idea of content-specific induction, draws upon current research in the area, and suggests roles and responsibilities of those involved in supporting new content specials.

S6.12.2 Progressive Development of Beginning Secondary Science Teachers: A Longitudinal Study

Steven Fletcher

This three-year study explores the evolving beliefs and practices of five prospective secondary science teachers from their recruitment course through the first year in the classroom. As an interpretive qualitative study, the format for data collection and analysis utilize a case-study methodology with cross-case comparisons. Data were collected through semi-structured interviews, instructional artifacts, and classroom observations. There are a number of important conclusions from this study. First, the teachers' beliefs about teaching shifted to a contemporary focus during the teacher preparation program, but ultimately returned to a teacher-centered orientation by their first year in the classroom. At the same time, the teachers' beliefs about learning remained consistently contemporary in nature. Second, the participants believed that they practiced teaching science as inquiry at a higher level than was indicated by researcher observations. Third, while the participants valued advanced content and educational theory coursework, they did not always see the link between these experiences and their development as science teachers. Finally, the findings from this study revealed contextual factors may impact, to varying degrees, the development of the science teachers. Implications from this study suggest a non-linear pattern of development of science teachers from pre-service education to the induction years.

S6.12.3 How Pedagogical Reasoning and Ambitious Practice Develops Across "Learning to Teach" Contexts

Jessica Thompson
Melissa Braaten, University of Washington
Mark Windschitl, University of Washington

In this study, we tracked the thinking and practices of a cohort of 11 novice secondary science teachers as they moved through four key contexts: the coursework of a teacher education program, student teaching, the first year of teaching in public school classrooms, and back to a collegial setting at the university to analyze evidence of their own pupils' learning during student teaching and the first year of teaching. Overall we found that teachers struggled to appropriate selecting and treating big ideas as models and working with science ideas in the classroom while pressing for explanation and working with students' ideas tended to be tried on or appropriated by teachers. We found it helpful to understand individual teacher's degree of appropriation in terms of the degree to which one's critical and contextual discourses interacted and overlapped. Critical discourses are described as a form of contextual discourses and a part of a teacher's pedagogical identity. Some critical discourses were honed prior to entering the teacher education program, some during and some are still in the making, but regardless of timing critical discourses powerfully shape one's current practices and curricular visions for future practices.

S6.12.4 Fostering Ambitious Pedagogy in Novice Teachers: The Collaborative Analyses of Pupil Work as a Bridge between Teacher Education and Early Career Practice

Mark Windschitl, University of Washington
Jessica Thompson
Melissa Braaten, University of Washington

In the research presented here, we describe how eleven secondary science teachers engaged in the regular analysis of their students' work over two years, spanning pre-service and in-service contexts. The analyses were facilitated by tools that allowed them to situate their current repertoire of instruction within an explicit continuum of development, and to visualize their practice as an object of critique, evidence-based analysis, and target of ongoing refinement. We seek to develop theory around engagement with collegial tool-based practices by novice teachers to extend the press for ambitious pedagogy from pre-service preparation into their first year of professional work. This research is unique not only for its look across early learning-to-teach contexts, but also because it links the analysis of student work with the evolution of classroom practice.

S6.13 Strand 8—SC-Paper Set: Conceptions, Misconceptions and Assessment

S6.13.1 Identification and Analysis of Science Teachers' Preconceptions Related to Avian Influenza

William L. Romine, University of Missouri
Marcelle A. Siegel, University of Missouri
Tina M. Roberts, University of Missouri

The topic of avian influenza is rarely addressed in our public school classrooms. Most of what people hear about the topic comes from the media. This study addresses common societal preconceptions related to avian influenza, as well as specific preconceptions held by science teachers, based on data from pre- and post-tests given at a recent institute for secondary science teachers. This institute was part of a five-year curriculum development project aimed at incorporating visual, inquiry-based lessons into biology classes at high-risk schools. Pre- and post-test results are presented as primary data to identify preconceptions before and after the institute and categorize them according to the five types of alternative science conceptions defined by the National Research Council; teachers' reflections are used as secondary data intended to collect teachers' opinions regarding the success of institute's activities and their applicability to high school science classrooms. The pre- and post-test data are used in conjunction with the teachers' reflections to qualitatively evaluate the success of the institute's activities in helping teachers change the alternative conceptions they carried into the institute.

S6.13.2 Chinese Middle School Science Teachers' Views of Nature of Science

Miancheng Guo, Illinois Institute of Technology
Norman G. Lederman, Illinois Institute of Technology
Martina Nieswandt, Illinois Institute of Technology

In the broad background of the ongoing Chinese science curriculum reform which emphasizes students' understanding of nature of science (NOS) and requires teachers to be educated to be eligible for implementing the new curriculum, this qualitative study explored Chinese middle school science teachers' views of NOS. It was found that the teachers did not have adequate understandings of the contemporary constructivist NOS and meanwhile had relatively strong positivist views of NOS. Their specific views of various aspects of NOS are presented and analyzed in this paper. Further, reflections on the possible origins of their NOS views are presented. Finally, implications for Chinese basic education and science teacher education were put forward.

S6.13.3 Enhancing Secondary In-Service Mathematics & Science Teachers' Assessment Literacy through a Web-Based Training Model

Ya-Ching Fan, National Changhua University of Education
Kuo-Hua Wang, National Changhua University of Education
Tzu-Hua Wang, National Hsinchu University of Education

The purpose of this study is to investigate the effectiveness of the assessment literacy development model called P2R-WATA (Practicing, Reflecting and Revising with Web-based Assessment and Test Analysis), on improving the assessment knowledge and perspectives of secondary in-service teachers. A single group for pre and post experimental design is adopted in the study involving 33 secondary in-service teachers. The study was implemented with a program, entitled "Test and Assessment in Mathematics and Natural Science". The program lasted for a total of 36 hours within 6 weeks. Quantitative data, including an achievement test on assessment knowledge and a survey on teacher's perspective on assessment are collected and analyzed. The major findings generally confirm the effectiveness of the model. Firstly, the assessment knowledge of the participants is found to improve after the training ($t=2.854$, $p < 0.01$), especially for teachers with low background knowledge. Secondly, a significant change in the teachers' assessment perspective is observed after the training. Suggestions on how to improve teacher's assessment knowledge and perspectives are also provided in this study.

S6.13.4 Nanotechnology Education: Challenges and Opportunities Employing STEM Curriculum

Leslie Flynn, University of Minnesota
Jeffrey D. Long, University of Minnesota

Calls to employ Science, Technology, Engineering, & Mathematics(STEM) education has catalyzed school districts to explore curriculum, training, and implementation for teachers as they integrate new interdisciplinary content with appropriate pedagogy. The area of nanotechnology has emerged as an exploding field of research and development in business and academia. Nanotechnology lends itself well as a topic for those interested in exploring STEM issues. How will this new model of learning and teaching impact teachers and the way professional development opportunities are structured? This study models twenty two in- service secondary science teachers' content knowledge, pedagogical content knowledge, and curriculum integration over the course of a school year following an intensive Nanotechnology Institute for teachers. Survey data were collected over four waves and analyzed with growth curves using linear mixed models (LMM); LMM accommodates missing data and allows the fitting of non-linear models. Growth curve analysis indicates significant increases in nanotechnology composite scores for both participants' skill to use ($p <.001$) and preparedness to teach ($P<.05$) with nanotechnology over the course of the school year. Insights on designing STEM institutes for teachers as well as successes and roadblocks teachers faced implementing STEM curricula will be discussed.

S6.14 Strand 10—Related Paper Set: Development, Implementation and Assessment of Popular and Relevant Science Modules: The PARSEL Project

S6.14.1 Increasing Science Teachers' Ownership through the Adaptation of the PARSEL Modules: A Bottom-Up Approach

Rachel Mamlok-Naaman, Weizmann Institute of Science, Israel
Ron Blonder, Weizmann Institute of Science, Israel
Mira Kipnis, Weizmann Institute of Science, Israel
Avi Hofstein, Weizmann Institute of Science, Israel

This study describes the process of adapting new curriculum materials, which had been developed in the PARSEL project in certain European countries, to the local educational science classroom of another country. The goal of the PARSEL project is to raise the popularity and relevance of science teaching by enhancing students' scientific and technological literacy by identifying suitable teaching–learning materials, based on relevant context-based educational approaches. All PARSEL materials are organized in a website and are freely accessible by science teachers around the world. In order to increase the teachers' ownership towards the new materials, we implemented a "bottom-up" approach, which included a teachers' workshop for modifying the PARSEL modules according to the teachers' needs. The teachers used the modified modules in their classes and reflected on the whole process after it was completed. The results were collected by various research tools: teachers' questionnaires, teachers' interviews, and the teacher focus group, which indicated that the "bottom-up" process increases teacher ownership towards the PARSEL modules and helps the teachers identify with the philosophy and the teaching style of the PARSEL project. It also indicated that the students found the modules to be popular and interesting.

S6.14.2 Scientific Literacy, Nuclear Physics, Peace, and Sustainable Development

Georgios Tsaparlis, University of Ioannina, Greece
Sotiris Hartzavalos, University of Ioannina, Greece

Nuclear physics has uses and applications that are relevant and crucial for world peace and sustainable development, so knowledge of its basic concepts and topics should constitute an integral part of scientific literacy. We have used two newspaper articles that deal with uses of nuclear physics that are directly relevant to life, society, economy, and international politics. One article discusses a new thermonuclear reactor, and the second one is about depleted uranium and its danger for health. Eighty-five first-year undergraduate physics were supplied one of the two articles each, and called to answer a number of accompanying questions dealing with knowledge that is part of the X high school curriculum. Acceptable answers were provided on average by around 20% of students, while a large proportion (around 50%) abstained from answering the questions. These findings are disappointing, but should be seen in the light of the limited or no coverage of the relevant learning material in the X high-school program. Also it would be of interest to repeat/extend such a study to other countries.

S6.14.3 Enhancing Students' Interests in Learning Science by Creating Innovative Learning Environments – The Berlin-ParIS-Project "Bio-Energy Sources"

Claus Bolte, Freie University, Berlin
Birgit Kirschenmann, Freie University, Berlin

Studies on learning environments show that students are not interested in the Sciences and science instruction because they experience the learning environment as not particularly motivating and science lessons as not offering meaningful personal orientation. The Berlin-PARSEL-project, which will be presented, is an intervention-study to promote upper high- school students' interests in learning science as well as to enhance their ability of proper judgment by creating an innovative and motivational learning environment in science classes. The findings of our intervention-study (n=641) – based on the investigation of special motivational learning environment scales – show how an innovative setting and relevant topics (like Climate Change, conventional energy supplies and Bio-energy sources) optimize the perceived learning environment and how this effects students' motivation and interests.

S6.14.4 Realizing PARSEL in German Schools – Interest, Scientific Literacy and German National Standards

Wolfgang Graeber, IPN, Kiel, Germany
Martin Lindner, IPN, Kiel, Germany

This presentation will contribute to the PARSEL paper set and show how PARSEL modules are introduced and evaluated in German schools. PARSEL is a coordinated action of partners from eight European nations, funded by the European Union, where we collect innovative science teaching modules, test them in different countries, identify best practice examples and disseminate those throughout Europe. Innovative to us means these modules deal with topics relevant to students' lives, help to raise students' interest in science, and promote students' scientific literacy. This is exactly what fits to the current German science education landscape. After analyzing the disappointing results of the TIMS- and PISA-studies, which caused a kind of "PISA-shock" in Germany, and looking at school systems of winning nations, several changes have been initiated in the German educational system. The most radical change to the German school system might be the introduction of national education standards in 2004. These standards do not focus on the content like the former curricula, but stress the development of competences which should be attained by the 9th or 10th graders who reach the middle level (Secondary I) exam. This paper shows how PARSEL modules help to realize the German standards in practice.

S6.14.5 The Readiness of Science Teachers to Implement PARSEL Modules for enhancing Scientific Literacy, and their Ownership of the Implementation.

Miia Rannikmae, University of Tartu, Estonia
Jack Holbrook, University of Tartu, Estonia
Klaara Kask, University of Tartu, Estonia

For promoting scientific literacy among students, a new philsophical approach "education through science" has been used in determining teaching and learning materials for PARSEL project. This was operationalised using a 3- step model: motivating students through relevant socio- scientific issue, inquiry based problem solving and socio-scientific decision making by teachers will be discussed. Data were collected from 9 science teachers over an 8 month period when these teachers were involved in teaching 27 different modules. Science teachers readiness for change and their ownership of the teaching were determined. Teachers readiness was illustrated by approaches taken in using an introductory scenario for motivating students to learn science. To move from readiness to ownership of the model, teachers needed different types of support. This is discussed.

S6.15 Strand 11—Related Paper Set: Grand Challenges and Great Opportunities in Place-Based Education in Science: Towards Socio-Cultural and Cultural-Historical Perspectives

S6.15.1 Critical Science Agency: Science in the making with and in place

Miyoun Lim, Georgia State University
Angela Calabrese Barton, Michigan State University
Edna Tan, Michigan State University

This ethnographic case study explores how urban youth take up discourses, tools, and practices of science to author and re-author their places for engaging science related concerns in their lives. We suggest how place-based, embodied science learning supported the youth in developing and then leveraging on their critical science agency. Since the science explorations were taking place in a particular context where the students' identities as legitimate stakeholders were integral, the students were empowered both to negotiate the ways in which they engaged with the science activities as well as to use the science knowledge and skills they gained to bring about strategic changes to the worlds they inhabit. We further discuss how, when critical science agency is grounded in the twin foundations of science as context and tool, the learning outcomes of science can transcend that of school knowledge to yield more enduring and meaningful impact in the identities and lives of students.

S6.15.2 Engaging the Pre-theoretical through Place-Based Education: A Foundation for Environmental/ Science Education

Doug Karrow, Brock University

This proposal summarizes findings from a research project focused on providing opportunities for teacher candidates to return to the things themselves; to pay conscious attention to the way things become manifest within our consciousness, or our pre-theoretical engagement with the world. Our findings demonstrate: (a) that such an engagement with the world corroborates Smith's (2007) claim that Place-based Education (PBE) experiences are motivated around developing in children a "sense of affiliation" where "care" emerges from interactions with their surroundings; and (b) how educational opportunities around the pre- theoretical could extend and inform notions of PBE and how we might engage children in such experiences prior to theoretical ways of viewing things, bracketed from their connections and engagements with our interests (Moran, 2000) leading to what we call science. We conclude that efforts toward educating in environmental/science education could be more meaningful and enriching if pre-theoretical experiences were provided for future students.

S6.15.3 Towards a Chronotopic Notion of "Place" In Place-Based Education in Science

Michiel van Eijck, Eindhoven University of Technology
Wolff-Michael Roth, University of Victoria

In current debates on place-based education in science, the notion of "place" is emerging as problematic. The purpose of this study is to contribute to a rethinking of place in a form that is appropriate for describing and theorizing its occurrence in a world we share with others. We understand place as the result of a dialectical and dialogical relation of the material world and its chronotopic nature in the various conversations (discourses) in which it is constituted as this place; that is, we view place as a lived entity that results from a dialogical transaction between a community and its environment at a particular moment in cultural-historical time and which hence shapes and is shaped by particular temporal and spatial categories. We exemplify our rethinking with a case of a science education project in which place unfolds as chronotope from a dialogue between scientific and indigenous voices. The implications of this rethinking of place for place-based education in science are discussed.

S6.15.4 The Roles of Place, Culture and Situated Learning in Teacher Agency in Science:

Pauline W.U. Chinn, University of Hawaii at Manoa

Cultural historical activity theory views teacher learning as a dynamic process in which expertise develops through participation in transdisciplinary activity networks. This case study of an effective science teacher for culturally diverse middle school students explores how personal and professional experiences influence the meanings and practices he brings to his own professional development. His activity networks include family, school, scientific, local and indigenous communities. Findings suggest that throughout their careers, science teachers benefit from participating in activity systems supportive of professional collaboration and transdisciplinary, cross-cultural learning, even when some of these appear unrelated to science education.

S6.16 Strand 15—Symposium: The Development of a National Curriculum in K-8 Science Education: How Should NARST Respond?

Richard A. Duschl, Pennsylvania State University
Angelo Collins, Knowles Science Teaching Foundation
Leona Schauble, Vanderbilt University
Richard Lehrer, Vanderbilt University
Janice Earle, National Science Foundation
Page Keeley, National Science Teachers Association

A number of major issues related to science education policy are being discussed at the national level. One of these issues is the possible development of a national K-8 science curriculum. The symposium will introduce some of the major policy documents that have discussed the issue (i.e., Rising Above the Gather Storm, American Competitiveness Initiative, America's Pressing Challenge, A National Action Plan) and ask science education leaders so present their thinking on a central question - The development of a national curriculum in K-8 science education: How should NARST respond? The presenters represent a variety of perspectives including cognitive science, science education research, science education policy, funding agencies, teacher education and teachers. The short presentations by the panelists will be followed by audience comments and the development of a short action plan to be submitted to the NARST board and membership.

S7.1 Presidential Invited Session—Constructing Linear Measures from Rating Scale Data with Rasch Modeling

Christine Fox, The University of Toledo
Toni Sondergeld, The University of Toledo

While many science education instruments use rating scale data to assess an attitude, belief, or behavior, the Rasch model can be used to determine the extent to which meaningful linear measures can be constructed from these ordinal data. Construction of linear measures results in a better-targeted instrument, a more refined rating scale, and a better understanding of how precisely different samples of students and teachers can be evaluated. Furthermore, linear measures are rigorously tested against a set of strict specifications, and hence are scientifically defensible. Using the Science Teaching Efficacy Belief Instrument–B (STEBI-B) for Preservice Teachers as an example, we will demonstrate how a variety of Rasch diagnostics can aid in using current rating scales to construct science education measures. Specific focus will be on rating scale categories, targeting and separation, exploration of dimensionality, and construct interpretation.

S7.2 Equity and Ethics Committee—Symposium: Exploring the Grand Challenges and Great Opportunities in Realizing a More Equitable Science Education

Jennifer Adams, Brooklyn College
Geary Cofford, University of Oklahoma
Cesar Delgado, University of Michigan
Allison Kang, University of Washington
Kihyun Ryoo, Stanford University
Stephanie D. Preston, Pennsylvania State University

The purpose of this symposium is to showcase scholars who are underrepresented in the science education research community as they present new and emerging scholarship that directly addresses the challenges of underrepresentation in science education. Their research raises and responds to the compelling questions of equity and ethics, then addresses those questions from multiple theoretical frameworks and methodological approaches. Together and individually, the work of these scholars affords NARST members a better understanding of the grand challenges and great opportunities in science education. This session features the research activities of six of the winners of the 2008 Equity and Ethics Committee scholarship. The discussion will examine the issues from both the teacher and student perspectives on the challenges in science education.

Ad Hoc Committee on the History of Science Education Committee Sponsored Session

S7.3 Ad Hoc Committee on the History of Science Education Committee Sponsored Session—Symposium: Increasing Our Influence with Today's Researchers, Practitioners, and Policymakers: Perspectives from Past and Present NARST Executive Secretaries and Directors

Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign
William Holliday, University of Maryland
Presenters (in order of their service as Executive Secretaries and Directors):
Paul Joslin (1975-80), Retired
William Holliday (1980-85), University of Maryland
Glenn Markle (1985-90), University of Cincinnati
John Staver (1990-95), Purdue University
John Tillotson (2002-07), Syracuse University
William Kyle (2007-2012), University of Missouri--St. Louis

This session brings together a panel of distinguished NARST members who served (or currently serve) the organization in the capacity of Executive Secretaries or Directors over the course of the past 34 years. The aim is to provide a historical perspective on the major goals and events pursued by NARST with regards to influencing research, practice, and policy in the field of science education. By commenting on NARST's major goals, work, and policies based on the participants' experiences while in office, the session aims to paint a portrait of the stable as well as evolving threads underlying NARST's role in impacting research, practice, and policy. The symposium begins with 5-minute presentations by each participant, followed by brief comments and a frank exchange of ideas among the participants. These exchanges are followed by questions and comments from the audience and reactions from presenters, with the aim of drawing some pointers on how to increase NARST's influence with today's research, practice, and policy.

S7.4 Strand 1—SC-Paper Set: Teacher Education and Broader Questions about Transfer

S7.4.1 Vygotsky and the Problem of the Zone of Proximal (Nearest) Development

Colette Murphy, Queens University Belfast

This work challenges some of the accepted ideas in relation to children's learning in science by providing a thorough analysis of Vygotsky's "zone of proximal (nearest) development". It fits well with the theme of NARST 2009: "Grand Challenges and Great Opportunities in Science Education" as challenging some well-worn but not very effective approaches to classroom science learning. It hopes to provide a fresh look at an old problem and empower colleagues to think anew about how best children learn science. The proposal author argues that many texts do not sufficiently examine Vygotskian constructs and simplify Vygotsky's contribution to science learning as teachers' scaffolding of children's learning. The 'zone of proximal development' (ZPD) is frequently described as a 'gap' between what the learner can achieve alone and what they can achieve with help from a teacher, parent or more competent peer. This description, however, bears little relation to Vygotsky's concept of the ZPD as one or more higher psychological functions which are in the 'process of maturing' (Vygotsky 1934/1987 p208). The presentation will explore the ZPD in relation to psychological functions and the acquisition of scientific concepts.

S7.4.2 The Role of Cognitive, Metacognitive, and Motivational Variables in Conceptual Change in Astronomy

Mesut Sackes, The Ohio State University
Kathy Cabe Trundle, The Ohio State University

This study investigated the role of metacognitive and cognitive strategy use (rehearsal, elaboration, and organization), and motivational beliefs (self-efficacy, goal-orientation, and task-value) in preservice teachers' understanding of lunar phases. Fifty-two preservice teachers who were enrolled in an early childhood science method course participated in the study. Two data gathering techniques were used. To reveal the participants' conceptual understanding of lunar phases, semi-structured interviews were conducted. The Motivated Strategies for Learning Questionnaire (MSLQ) was used to assess the participants' level of motivation and use of cognitive and metacognitive strategies. The framework of codes developed in previous lunar concepts studies and constant comparative analysis were used to determine the participants' conceptual understandings. Participants' conceptual understandings were then scored with a scoring rubric. Hierarchical multiple regression analysis was used to investigate whether cognitive, metacognitive, and motivational variables have explanatory power for participants' conceptual understanding scores. Results showed that while the metacognitive strategy variable alone accounted for a significant portion of the variance in conceptual understanding in the second step after controlling for pre-conceptual understanding, its significance diminished after entering cognitive strategies and motivational beliefs variables in the third and fourth steps respectively. Metacognitive strategy use was the best predictor of conceptual change.

S7.4.3 Participants' Thinking When Interacting with a Web-Based Environment to Help Elementary Teachers Better Understand Floating and Sinking

David E. Brown, University of Illinois at Urbana-Champaign
Seongmi Lee, University of Illinois at Urbana-Champaign

A serious issue of practice is that science teaching at the elementary level is often of very low quality, in large part because of the frequently low level of teachers' own conceptual understanding of the science ideas they are asked to teach. Instructional interviews with twenty college students from an educational psychology class (all prospective elementary teachers take this class) helped with formative evaluation and revision of web-based resources, showed that the resources were effective in increasing the participants' conceptual understanding of buoyancy, and contributed to the further articulation of the theoretical perspective on teachers' conceptions as a dynamic system of conceptual components. A strong "conceptual attractor" identified was that an object sinks because there is a downward agency that is more than an upward agency or resistance. For example, students talking about density typically cast it as downward agency rather than simply mass per unit volume. Instruction took advantage of this conceptual attractor by discussing weight as downward agency and buoyant force as upward agency. Buoyant force was anchored in the commonly shared experience of trying to push a beach ball into the water—the deeper you push it, the more it pushes back on your hand.

S7.4.4 The Three Dimensions of Transfer

Irit Sasson, Israel Institute of Technology

Yehudit Judy Dori, Israel Institute of Technology/Massachusetts Institute of Technology

Transfer refers to students' ability to recall knowledge and skills and to apply them in new learning contexts therefore there is a need to provide an education that lasts a lifetime with transfer of learning being a major goal of instruction. Our review of over 480 papers on transfer, which is the first of its kind, revealed that there are different definitions for transfer thus in our goal to identify the main components of transfer used in these articles, we came up with three dimensional framework: similarities and differences between learning situations; knowledge being transferred, contexts, domains, or disciplines; and thinking skills or strategies. Our review contributes to the body of literature of transfer. At the theoretical level, we have pointed out commonalities and differences between the various current transfer definitions and proposed a modified 3D transfer skills framework.

S7.4.5 A Comparison of Didactic and Guided Inquiry Instruction in Facilitation of Transference

Sarah J. Rogers, Brigham Young University
Christina Fox Call, Brigham Young University
Laura P. Chisholm, Kearns Junior High
Christian K Davies, Brockbank Junior High
David Kent, Independence High School
Adam Mitchell, Diamond Fork Junior HIgh
Sara Wurstn, American Leadership Academy
Dennis Eggett, Brigham Young University
Nikki L. Hanegan, Brigham Young University

This study examines the relationship between guided inquiry and didactic instruction with reference to transference of knowledge. Didactic or direct instruction can be described as teacher-centered instruction where students are required to learn, memorize and reiterate knowledge-based facts (Furtak, 2006; Taraban et al., 2007). Guided inquiry is an interactive scientific investigation where students are given the opportunity to decide how they will solve a scientific problem (Author, 2007; Colburn, 2000; Taraban et al., 2007; Thier, 2002). Transference is defined as defined as the ability to "apply what was learned in new situations and to learn related information more quickly" (NRC, 2000, p. 17). Guided inquiry and didactic lessons were conducted in 12 classes with 421 students taught by four different teachers. The participating teachers were simultaneously trained on both the instructional methods and the assessment rubrics. Transference was measured using a practice assessment and then at a later date the transference assessment. The effectiveness of didactic teaching and guided inquiry were analyzed for various student groups including ESL and special education classified students. Analysis suggested that guided inquiry classrooms exhibited a higher probability of transference (probability =.476) compared to didactic classrooms (probability =.343 and p =.0568).

S7.5 Strand 1—Strand Invited Symposium: Finding Connections between Psychological and Sociological Perspectives in Conceptual Change

David F. Treagust, Curtin University, Australia
Reinders Duit, Leibniz Institute for Science Education, Germany
Kenneth Tobin, City University of New York
Kathryn Scantlebury, University of Delaware
Sonya Martin, Drexel University
Michiel W. van Eijck, Eindhoven University of Technology, The Netherlands

Conceptual change research emerged from Piagetian psychology where data of learning were obtained through the clinical interview. Where is conceptual change research now? We begin to address this question by acknowledging that conceptual change researchers are developing more nuanced understandings of conceptual change beyond the historical exchange model. Recent models support students' understanding of the role of context when deciding how to represent their conceptions expanding directions for understanding learning. However, much conceptual change research has been reductionist failing to address social, cultural, and historical phenomena. Accepting science as a culture in unbounded fields structured by resources, a social-historical framework offers a more expansive framework for studying science learning. Additionally, if conceptual change theory is to continue to be based on valuing personal experience, the research and teaching communities need to recognize how gendered those experiences can be. Application of feminist psychological and sociological theories informs future directions for conceptual change research. Finally, how can we understand that even though conceptual change theory is becoming increasingly sophisticated, science teachers continue to ignore its possible utility for instruction? A hermeneutic phenomenological perspective suggests that focus on the individual learner in conceptual change research does not represent the pedagogical experience of teachers.

S7.6 Strand 2—SC-Paper Set: Discourse and the Logics of Argumentation in Science Communities

S7.6.1 High School Students' Use of Argumentative Skills during Inquiry-Based Activities

Aracelis J. Scharon, IIT
Martina Nieswandt, IIT
Norman G. Lederman, IIT

This exploratory study investigated student argumentative skills in two physics high school classes over the duration of three weeks. Using classroom observations, an open-ended questionnaire, and teacher and student interviews discourse patterns were analyzed during inquiry-based activities. The results of this study indicate that our participants possessed and used higher level argumentation skills, but the use of these skills was dependent on what was expected from them in the different context. Thus, our study supports the importance of the teachers' expectations or goal orientation and students' ability to selectively transform these goal messages into their own motivational structure.

S7.6.2 Analogical Mapping as a Scaffold for Student Argumentation

Brandon R. Emig, Penn State
Scott J. McDonald, Penn State
Carla Zembal-Saul, Penn State

Research problems with student argumentation in science have included: providing scaffolds to structure student argumentation, defining and measuring quality in argumentation, getting students to refer to multiple sources of evidence and evaluate the quality of this evidence, and obtaining productive argumentation from students about things they do not yet understand. This preliminary research suggests that inviting students to use explicit analogical mapping for argumentation may provide scaffolding. The constraining effects of analogies may also provide a referent for increasing and measuring the quality of student argumentation. In this study university students, both science and non-science majors, were invited to compare various simple machines and argue which two simple machines (among five) were the most analogous. This research involved twelve groups of four students each. Half of the groups was given instruction in analogical mapping and instructed to use it in their argumentation; the other half was not. Student argumentation was affected by the instruction in various ways. Notably, groups receiving the instruction used more analogical constraints in their argumentation. Also, students employing analogical mapping to compare simple machines tended to hold more sway with their peers and provide more robust arguments. This may be due to the fact that analogical mapping requires more than one correspondence to be made between analogues increasing triangulation during argumentation.

S7.6.3 Classroom Communities Adaptations of the Practice of Scientific Argumentation

Leema K. Berland, University of Texas at Austin
Brian J. Reiser, Northwestern University

Scientific argumentation is increasingly seen as a key inquiry practice for students in science classrooms. There are three overlapping instructional goals for facilitating student participation in this complex practice: 1) using evidence and general science concepts to make sense of the specific phenomena being studied; 2) articulating these understandings; and 3) persuading others of these explanations by using the ideas of science to explicitly connect the evidence to the knowledge claims (authors, in press). This study examines the argumentative discussions that emerge in four middle school science classrooms in order to explore the variation in how these goals are taken up. This study reveals that the instructional goals of scientific argumentation may be in tension with one another: In some contexts it may not make sense for participants in an argument to both attempt to make sense of a phenomenon and persuade some one of their understanding at the same time. Instead, it appears that scientific arguments that emphasize these goals individually have value in their own context and that educators may need to engage in multiple argumentative discussions—each with a different focus—in order to achieve all of the goals of scientific argumentation.

S7.7 Strand 4—Symposium: A Longitudinal Study on Pedagogical Content Knowledge: Synthesizing our Research on Content, Pedagogy, and Practice

Valerie K. Otero, University of Colorado Boulder
Noah D. Finkelstein, University of Colorado Boulder
Robert M. Talbot, University of Colorado Boulder
David C. Webb, University of Colorado Boulder
Laura J. Moin, University of Colorado Boulder
Michael W. Klymkowsky, University of Colorado Boulder
Joeseph Krajcik, University of Michigan

The Learning Assistant (LA) model uses the transformation of large-enrollment science courses as a mechanism for recruiting and preparing talented science majors for careers in teaching. Through recent funding, we have embarked on a large-scale, multi-disciplinary, longitudinal research project to study teacher recruitment and the effectiveness of our program in enhancing students' content knowledge, their pedagogical knowledge, and their K12 teaching practices. In this symposium, our three research teams comprised of math, science, and education faculty members and students will summarize their work in each of these areas. They describe their research and the measurement instruments used, and present qualitative and quantitative data to support claims about the program. Audience interaction and reactions to our work will be encouraged, and time will be provided for discussion among attendees about future directions for and replications of large-scale programs such as this one.

S7.8 Strand 6—Strand Invited Symposium: NARST CAISE Symposium: Exploring the ISE Landscape and Determining Value in Informal Science Contexts

Scott Randol, Oregon State University
Lynn D. Dierking, Oregon State University
Kevin Crowley, University of Pittsburgh
John Baek, Oregon State University

This symposium will give members of the NARST Informal Science Education (ISE) Strand an opportunity to help guide the directions of the recently created National Science Foundation funded Center for the Advancement of Informal Science Education (CAISE). The first portion of the session will involve a presentation of a research project designed to explore and document the current landscape of the informal science education (ISE) community. Data were collected through in-depth, semi-structured telephone interviews with 25 professionals working in areas related to communicating science to the public (Science Center, Youth/Adult Community Organizations, Zoos and Aquariums, Public Television and Radio, for example.) Results from this exploratory investigation suggested that currently the ISE community does not function as an effective community of practice, though many of the pieces necessary for ISE to become such a community are in place.

Emerging from this investigation will be a discussion designed to unpack and further explore, through small and large group conversations, what "evidence" demonstrating the value and impact of ISE might look like. Furthermore, to what extent do answers to this and related questions vary as function of the different communities within ISE, as well as those communities ISE seeks to be a part of (e.g., science education community, education policy community and learning research community)?

S7.9 Strand 7-Related Paper Set: Promoting Pre-Service Science Teachers' Knowledge for Teaching

S7.9.1 The Development of PCK in the Context of Pre-Service Science Teacher Education

Jan van Driel, Leiden University, The Netherlands
Julie Gess-Newsome, Northern Arizona University

Although there seems to be consensus about the importance of pedagogical content knowledge as central to the knowledge base teachers need to teach science effectively, the research literature on PCK is ambiguous and difficult to access for science teachers and teacher educators. The literature contains different conceptualizations of what PCK is, and different ideas as to how the concept could be used effectively in science teacher preparation programs. This paper presents a brief overview of what is known from the research literature on pre-service science teacher education about the development of the various components of pedagogical content knowledge. This overview serves as a framework to the presentation of three studies, all of which studied the development of pre-service and beginning science teachers' PCK in the context of different science teacher education programs.

S7.9.2 Investigating the Development of Science Teaching Orientations during an Alternative Certification Program

Pat Brown, University of Washington at St. Louis
Pat Friedrichsen, University of Missouri

Science teaching orientations have been theorized as a critical component within the Pedagogical Content Knowledge (PCK) model; however, few empirical studies investigate the nature and sources of science teaching orientations. The purpose of this study was to investigate how science teacher orientations develop in an alternative certification program (ACP). Data sources included a lesson planning task at the beginning of the program, interviews after the first summer of ACP coursework, an interview-observation cycle during the prospective teachers' first and second semesters of teaching, and interviews with the mentor teachers. We constructed profiles of 4 prospective teachers and 4 mentor teachers and generated a set of assertions based on a cross-case analysis. ACP prospective teachers' science teaching orientations were complex, consisting of multiple dimensions. Although each teacher added goals and/or views of the teacher's role, their science teaching orientations were highly resistant to change. The mentor teacher had the greatest impact on prospective teachers' science teaching orientations, and in particular, on the elaboration of goals and views of the teacher's role.

S7.9.3 The Role of Pre-Service Elementary Teachers' Pedagogical Content Knowledge for Science Teaching in Learning to Engage in Curricular Planning

Carrie J. Beyer, University of Michigan
Elizabeth A. Davis, University of Michigan

Teachers often engage in curricular planning by critiquing and adapting existing curriculum materials in order to contextualize the resources and compensate for their deficiencies. Designing instruction for students is shaped by teachers' ability to apply a variety of personal resources, including their pedagogical content knowledge for science teaching. However, engaging in this teaching practice is no easy task, especially for novice teachers. This study investigated one approach to teaching pre-service elementary teachers how to plan with science curriculum materials. The pre-service teachers learned about seven dimensions of science teaching and how to attend to these dimensions as criteria in their analysis of science lesson plans. Results show that the pre-service teachers understood how to attend to learning goals and establish a sense of purpose but struggled with understanding how to assess students and make science accessible. Additionally, across all of the different dimensions of science teaching, the pre-service teachers demonstrated a range of alternative understandings in their analyses. Finally, the pre-service teachers' pedagogical content knowledge improved over time when they had the opportunity to practice applying the criteria using different lesson plans. Implications for science teacher education and future research on teacher knowledge are discussed.

S7.9.4 Learning to Teach and Teaching to Learn - Student Teachers´ Teaching Concerns for Learning to Teach Primary Science

Pernilla K. Nilsson, Halmstad University, Sweden

The research reported in this paper is based on an exploration of the ways in which student teachers learn about the issues and concerns that shape their own professional learning. Shulman's process of pedagogical reasoning and action was used as a conceptual framework to systematically elucidate different critical incidents that student teachers experienced within their teaching in order to develop deeper understandings of the complex task of learning to teach primary science. Primary science student teacher participants (n = 22) were stimulated to reflect upon critical incidents in order to facilitate identifying their teaching concerns and teaching needs. The data collected consisted of: (A) the results from questions to the student teachers before the lesson; (B) responses by the school pupils, and (C) student teachers' written answers to a questionnaire, plus audio-recordings of group discussions about the student teachers' experiences. Among others, the results indicate that the student teachers understood the need to put scientific concepts into an everyday situation for their pupils, so that pupils might better understand different phenomena. They also emphasized the need to have a large repertoire of experiments and activities, and the need to know about pupils' earlier experiences and specific learning needs.

S7.10 Strand 8—Symposium: North Coast Teachers Touching the Sky: Lessons Learned, Challenges, and Paradoxes of Creating Coherent Professional Development

Ed Armstrong, Tillamook School District #9, Oregon
Greg Bothun, University of Oregon
Edith Gummer, Northwest Regional Education Laboratory
Rick Kang, Friends of Pine Mountain Observatory, Oregon

What does coherent, teacher-centered professional development look like? This symposium will present the lessons learned, successes, and paradoxes experienced during North Coast Teachers Touching the Sky (NCTTS), a three-year State ESEA Title IIB Math/Science Partnership (MSP) project. The goal of the symposium is to invite conversation around issues of designing and implementing coherent, teacher-centered science teacher professional development, with a focus on Title IIB MSP and similar projects. The session will begin with a brief overview of the Title IIB Math/Science Partnerships, a U.S. Department of Education initiative of the No Child Left Behind (NCLB) law of 2001. This short introduction will be followed by a more detailed description of North Coast Teachers Touching the Sky (NCTTS), a three-year professional development program involving a group of 55 K-12 teachers drawn from a handful of small, rural, high-needs school districts. Artifacts illustrating the structure, features, and outcomes will be displayed for those interested in designing a similar project. After these initial descriptions, issues related to implementing coherent, teacher-centered professional development will be illustrated through a bricolage of NCTTS participant narratives, including K-12 teachers, university scientists and science educators, school district administration, external evaluators, and informal science staff.

S7.11 Strand 8—Related Paper Set: The Communication in Science Inquiry Project: The Challenges of Professional Development

S7.11.1 The Challenge of Measuring Fidelity of Implementation of Professional Development

Dale Baker, Arizona State University
Nievita Bueno-Watts, Arizona State University
Elizabeth B. Lewis, Arizona State University
Senay Purzer, Purdue University

The Challenge of Measuring Fidelity of Implementation of Professional Development This paper discusses the challenge of developing an instrument to measure the fidelity of teachers' implementation of the Communication in Science Inquiry Project (CISIP) professional development strategies. It reports on the factor structure of the DiISC (Discourse in Inquiry Science Classrooms) based on 204 observations of middle and high school teachers. Five factors were identified based on the scree test, Eigen values, and the interpretability of the factor solution using Varimax rotation. They were Teaching Inquiry Skills, Teaching Discourse Strategies to Learn Content, Teaching Discourse Strategies to Support NOS and Metacognition, Teaching Formal Writing in the Context of Student Abilities Assessing Students and Modifying Instruction. The factors accounted for 46.1% of the variance. The factor structure of the analysis differs from the original organization of the DiISC, which was designed to reflect the major components of the professional development strategies presented to teachers (i.e., inquiry, oral and written discourse, academic language and learning principles). However, the factor structure accurately reflects how teachers implement strategies in their classrooms. Teachers do not teach or use strategies in isolation but teach and use them in various combinations to reach their specific learning outcomes.

S7.11.2 The Impact of CISIP on Elementary Teachers' Views of Nature of Scientific and Scientific Communication

Gita Perkins, Arizona State University
Senay Purzer, Purdue University
Sibel Uysal, Arizona State University
Sissy Wong, Arizona State University
Dale Baker, Arizona State University
Elizabeth B. Lewis, Arizona State University
Rachelle Beard, Arizona State University

The purpose of this study is to examine changes in teachers' views of nature of science and scientific communication (NOSSC) in over a three-month period. The sample included thirty fifth and sixth grade teachers who participated in the Communication in Science Inquiry Project (CISIP). We asked teachers to define nature of science and nature of science communication using an open-ended response survey in April, May, and June. Teachers' responses were coded using a Nature of Science and Scientific Communication (NOSSC) coding scheme. Inter-rater reliability was established among four raters. One-way repeated measures ANOVA was used to assess changes over time. A paired samples t-test was also conducted. Results indicated a significant time effect in which an increase in NOSSC views was observed between April and May ($t(29)=-4.36$, $p=.00$), but not between May and June ($t(29)=.66$, $p=.52$). Recommendations for teacher professional development activities are discussed.

S7.11.3 From Professional Development to the Classroom: What changes Do Students Experience?

Nievita Bueno-Watts, Arizona State University
Dale Baker, Arizona State University
Elizabeth B. Lewis, Arizona State University
Sibel Uysal, Arizona State University
Senay Purzer, Purdue University
Rachelle Beard, Arizona State University
Sissy Wong, Arizona State University
Gita Perkins, Arizona State University
Monica Pineda, Arizona State University
Michael Lang, Maricopa Community College District

We have conducted a study assessing the relationship between science teacher professional development Communication In Science Inquiry Project (CISIP) and its effect on student perceptions of their classroom environments. We found that: 1) there is a significant difference in what happens in science classrooms as perceived by students of teachers who have participated in CISIP professional development as opposed to students of teachers who have not, 2) there is no significant difference in the way middle school and high school students in the comparison group perceive their classroom environment, but high school students of teachers involved in the CISIP PD perceive classroom environments that are more aligned with the CISIP model than middle school students of CISIP-trained teachers are, and 3) student perceptions of their classroom environment and research team classroom observations are aligned. Students who have science teachers who have participated in CISIP professional development are likely to see a change toward a classroom that can be considered a scientific classroom discourse community, use science notebooks, increase their scientific writing, learn science through scientific inquiry methods, and participate in activities that support academic language acquisition.

S7.11.4 Using HLM to Analyze On-Going Teacher Professional Development and Implementation of Scientific Classroom Discourse Community Strategies

Elizabeth B. Lewis, Arizona State University
Dale R. Baker, Arizona State University
Michael Lang, Maricopa Community College District
Brandon Helding, Arizona State University

One-hundred-and-sixty classroom observations of secondary science and language arts teachers were made throughout the 2007-2008 school year to determine the extent of their use of the professional development, specifically in how to construct a scientific classroom discourse community (SCDC). Each observation was scored using a 36- item instrument of various SCDC facets. These observation scores and teacher demographic information were used to build a hierarchical linear model to explore for statistically significant relationships over time. The length of time that the teachers received professional development was chosen as the exclusive predictor of teacher change because the overall model fit associated with this variable was better, co-varied less across levels, and ultimately because it was most conceptually significant. Thus, sustained professional development over time, greater than one year, appears to be more effective, and necessary, for greater implementation of such SCDC teaching strategies. The results of the modeling also suggest that the professional development appears to work well for a variety of participants and is adaptable and equitable.

S7.11.5 The Relationship between Quality of Teacher-Designed Lesson Plans and Teaching

Rachelle Beard, Arizona State University
Elizabeth B. Lewis, Arizona State University
Senay Purzer, Purdue University
Sibel Uysal, Arizona State University
Sissy Wong, Arizona State University

The Relationship between Quality of Teacher-Designed Lesson Plans and Teaching Abstract This study compares teachers' use of key professional development components in lesson plans that they created as part of a professional development with an actual observed classroom lesson. It also discusses format changes made in the lesson plan outline provided to teachers during the professional development based on feedback obtained after a pilot run of the original lesson plan outline. A total of 37 lesson plans were analyzed at the completion of the 2007-2008 academic year, submitted by 29 teacher participants. A total of 133 classroom observations were conducted. Correlations between the classroom observation and the lesson plan scores were not significant ($r= .39$, $p=.24$). Findings suggest that teachers were able to write quality lesson plans, but were unable to transfer their newly gained knowledge to their teaching. Recommendations include formatting of the lesson plan outlines to allow for metacognitive teacher reflection of learning during the professional development.

S7.12 Strand 10—SC-Paper Set: Studying the Implementation and Scale-Up of Curriculum Innovations

S7.12.1 Assessing Student Learning in a 6th – 8th Grade Space Science Curriculum

Kristin M. Nagy Catz, University of California, Berkeley
Ann Barter, University of California, Berkeley

The paper examines student learning, as shown by unit pretest/posttest change, in the Great Explorations in Math and Science (GEMS) Space Science Sequence (SSS) sixth to eighth grade curriculum. The sequence is made up of four units that build key concepts in Earth and Space Science, related to our place in the Solar System, our Galaxy, and the Universe. Pretest to posttest student learning gains were statistically significant for all units. Effect sizes were statistically significant for all units and ranged from .33 to .59. Grade level comparisons (6th, 7th, and 8th) found statistically significant gains for all units across all grade levels. Results suggest consistent evidence of the effectiveness of the curriculum.

S7.12.2 Development of a Fidelity of Implementation Observation Instrument for a Reform-Oriented Science Program

April L. Gardner, BSCS Center for Research and Evaluation
Janet Carlson, BSCS Center for Research and Evaluation
Jane O. Larson, BSCS Center for Research and Evaluation

Evaluating the impact of reform-oriented curriculum materials on teaching and learning requires that researchers assess whether these materials are implemented as intended. This study describes the development of an observation instrument to assess fidelity of implementation (FoI) for such materials. The initial FoI instrument was a single rubric with rows describing the phases of an instructional model used in a reform-oriented program. Each phase was scored 0, indicating no implementation, to 1, 2, or 3, indicating increasing levels of implementation. Researchers used this instrument to score sets of videotapes from each of ten teachers. Inter-rater reliability was adequate, and correlation analyses found medium to strong positive relationships between FoI and teacher's subject matter knowledge, hours of curriculum-based professional development, teacher's agreement with key findings about how people learn, and student post-test achievement. Based on these promising results, the FoI instrument was reviewed and significantly revised to improve its use and reliability. The final FoI observation instrument is composed of sub-rubrics for each phase of the instructional model, with criteria that address distinctive features of reform- oriented materials. An adapted version of this instrument has been developed to assess the FoI of another reform-oriented program that uses a different instructional model.

S7.12.3 Effectiveness of a Middle School Chemistry Curriculum during Scale-Up: A Three- Year Perspective

Joi D. Merritt, University of Michigan
Namsoo Shinn, University of Michigan

Over the past four years, we have been developing the Investigating and Questioning our World through Science and Technology (IQWST) curriculum. This study centers on the 6th grade chemistry unit of the IQWST curriculum entitled "How can I smell things from a distance?" The purpose of this study is to describe our approach to scaling up and evaluate the effectiveness of the curriculum during this process as the curriculum has gone from a small scale pilot involving a single teacher and her 57 students to a large-scale national field trial involving 28 teachers and 3,000 students. Key features of our scaling-up process include the development of student assessments and professional development for teachers.

S7.12.4 The Creation, Validation, and Reliability Associated with the EQUIP (Electronic Quality of Inquiry Protocol): A Measure of Inquiry-Based Instruction

Jeff C. Marshall, Clemson University

Abstract: K-12 science teacher self-report that 39% of classroom instructional time is devoted to inquiry-based instructional practice, but the quality of this instruction is largely unknown. Current observational protocols seem either too broad by looking at instructional practice in its entirety (e.g., classroom management, instructional practice, assessment), or they seem too specific by considering only one aspect of inquiry-based instruction. Therefore, there was a perceived need to develop a protocol that seeks to look at the major constructs of inquiry-based instructional practice. The eQUIP provides a valid, reliable way to measure the quality of inquiry being led and focuses on four central constructs (usage of time, instructional factors, curriculum factors, and ecology issues). The development and standardization of the protocol is the central focus for this paper. The implications for the protocol's use include: (1) providing a systematic way to guide teacher transformation toward more inquiry-based instructional practice, (2) serving as a guide for teacher development programs (both pre- and in-service) by pinpointing strengths and weaknesses relative to inquiry-based instruction, and (3) guiding curriculum development by checking to ensure that the instructional framework is complete and supportive of improving academic achievement relative to inquiry learning.

S7.13 Strand 11—Related Paper Set: Language of Science in Urban Schools: Transitions from d to D

S7.13.1 Comparative Discourse Analysis of Third Grade Urban and Suburban Students Learning Science

Carmen (Karin) I. Mendoza, University of Cincinnati
Piyush Swami, University of Cincinnati

This qualitative research project examines the intersection of race, social class, language, and the central role science teachers play mediating between children's everyday world and the world of science. Critical discourse analysis provides both the theoretical framework and

micro-sociocultural level analytical lens comparing how two middle-class, European American science teachers enact the same kit-based, inquiry science curriculum with their respective urban and suburban students. The overarching goal is to identify underlying micro-level linguistic factors contributing to the persistence of the gap in achievement between urban and suburban students in science. The research also intends to inform best practices for science educators and serve as a springboard for future educational science researchers' use of critical discourse analysis.

S7.13.2 Learning to Move from d to D: Urban Preservice Science Teacher Candidates' Transition from Vernacular to the Language of Science

Hedy Moscovici, California State University
Irene Osisioma, California State University

The purpose of this study is to explore pre-service elementary teachers' understanding and use of the five features of inquiry through the analyses of their written artifacts written throughout the science methods course. A total of 121 pre-service elementary teachers participated in this study and identified reactions to readings, the preparation of the multi- day science lesson, and teaching of one science lesson in K-5 classrooms, the "Rot-it-Right" curriculum, and the use of science inquiry as their best learning opportunities in class. The study presents a holistic analysis of pre-service teachers' science discourse embedded within a sociocultural context that enabled us to make sense of their levels of understanding of the features of inquiry.

S7.13.3 "Walk and Talk Like Scientists": Seventh Grade Urban Students Share Their Perceptions and Beliefs of How a Change in Science Classroom Instructional Practices Helped Them Make the Transition from the Language of Home to the Language of Science

Claudette L. Giscombe, University of Massachusetts, Amherst

This qualitative study was conducted with students from three seventh grade classes of different academic performance rankings in culturally and linguistically diverse urban classroom settings. The study was done to determine the perceptions and beliefs of students about how a new instructional approach, Project-based Instruction (PBI) (Krajcik, Czerniak, & Berger 1999) had impacted their learning, value of scientific knowledge, and attitudes toward science. The data that was collected over three months was from student interviews and questionnaires; classroom observations; science fairs projects; and student journals. The interpretation of the findings was the result of ongoing cross analysis and triangulation of the data. The data revealed that the students believed the new instructional approach required them to work harder, improved their science vocabulary, increased their learning and interests in science, as well as motivated them to do more in science and to 'walk' and 'talk' like a scientist.

S7.13.4 Moving From d to D through the Eyes of Five Urban African American Science Teachers

Pamela Fraser-Abder, New York University

This study highlights the factors that contribute to excellence in urban science teaching as pinpointed by five urban science teachers who graduated from the same masters program and have continued teaching in the urban system for over ten years. These teachers shared their experiences prior to and after graduation and reflected on the qualities that contributed to their success and persistence as urban science teachers. One of the most critical factors that contributed to their success and persistence was their ability to understand and care for their students. Other contributing factors included in-depth knowledge and love of science, caring and commitment to the whole child, effective classroom management strategies, high expectations and motivation of their students, and an understanding and acceptance of the varying parental involvement in the educational decisions about their child. Their stories highlight strategies they used to move their students from d to D.

S7.14 Strand 13—SC-Paper Set: Science, Society, and Argumentation

S7.14.1 Situated Learning in Science Education: Socioscientific Issues as Contexts for Practice

Troy D. Sadler, University of Florida

In this paper, situated learning is applied as a theoretical perspective for considering the aims and focus of science education. Perspectives on situated learning are presented as well as discussions of some of the central constructs including knowing and learning as practice, communities of practice, enculturation, Discourse, and identity. A situated perspective is used to critique current trends in science education and the tenuous connections between communities of school science and professional science. The discussion then turns to focus on how science is used in the lived experiences of individuals not involved in professional science and how all individuals confront socioscientific issues. These ideas serve as a backdrop against which an argument is developed for featuring socioscientific issues as a primary element of science education. It is further argued that promoting student development of "socioscientific Discourses" and the identities to support these Discourses ought to be significant aims for science educators. Implications for practice and policy are discussed.

S7.14.2 Relationship between Nature of Science and Argumentation Skills

Rola F. Khishfe, Loyola University Chicago

The study investigated the relationship of high school students' understandings about NOS aspects and their argumentation skills. The study was conducted in five schools from different geographical locations in a Middle eastern city. Participants were a total of 219 grade 11 students. Students were administered a survey, which had two open-ended scenarios that addressed controversial socioscientific issues. The two scenarios were followed by two sets of questions relating to argumentation and NOS. Analysis occurred at two levels: analysis of participants' views of the target NOS aspects and analysis of participants' argumentation. Chi-square tests were performed between each of the emphasized aspects and an argument, a counterargument, and a rebuttal. Results and implications for the teaching of NOS and argumentation skills are discussed.

S7.14.3 College Students' Perspectives of Science in Their Everyday Lives

Jacqueline Wong, University of California, Los Angeles
William A. Sandoval, University of California, Los Angeles

This study describes how college students view science and how they perceive science to be part of their everyday lives. Understanding the nature of science (NOS) is argued to be important in helping people deal with science-related situations in their lives. However, research remains inconclusive regarding how different understandings of NOS influence people's reasoning and actions in everyday settings. We expanded on this body of work by considering students' views of science as knowledge and as methodology in addition to their views of NOS. College students in non-STEM majors were interviewed using a semi-structured protocol. We found that almost all students held more than one view of science. Science as knowledge and methodology dominated the students' responses, but most students described at least some aspect of NOS. While these views of NOS seem to influence how students interact with science in some instances, we found that views of NOS can surface as relevant to using science as methodology but not to encountering science as knowledge in the same student. Our findings suggest that situating students' views of NOS with their other views of science might help researchers interpret how NOS becomes influential in students' reasoning and actions.

S7.14.4 Science, Technology, and Society: A Deweyan Perspective

Nidaa Makki, The University of Akron
Wendy Sherman Heckler, Otterbein College

The goal of teaching science for social responsibility, which is exemplified by the STS approach, is established in reform documents. This paper takes a Deweyan perspective that focuses on "worthwhile experiences" and interactions in the world, to explore the possibilities that STS curricular approaches offer teachers to implement the national recommendations of "Scientific Literacy for All."

S8.1 Presidential Invited Session—A Theory of Action for NSF Educational Research: Strategies and Directions of the Division of Research on Learning in Formal and Informal Settings (DRL)

Joan Ferrini-Mundy, National Science Foundation
Janice Earle, National Science Foundation
Sharon Lynch, National Science Foundation

In this presentation we will describe the "theory of action", embodied in a cycle of innovation, that has been developed for funding of STEM educational research in programs sponsored by DRL, using examples of funded projects to illustrate the variety of research that has been and is being supported. This talk and the subsequent portion of the symposium will explore such questions as: Do the examples illustrate adequately the potential of the cycle for generating lines and programs of research? Is the cycle a useful conceptual frame for envisioning the research programs of a federal funding agency? How does the cycle and the associated funded work lend itself to an agenda of transformative research? How are the research programs in DRL situated relative to recent calls for rigorous research to identify causal effects? Are the components of the cycle adequately specified? Is the research portfolio likely to lead to progress on the most pressing issues challenging STEM education? Following the presentation, three discussants who have experience with NSF education research funding will address the questions listed above, as well as providing suggestions for funding and methods of improving the framework of the cycle.

S8.2 Research Committee Sponsored Session—Technology Symposium: Changing the Way the World Learns

Kathleen Fisher, Center for Research in Mathematics and Science Education
Michelle Nolasco, Center for Research in Mathematics and Science Education
Ryan Gallagher, High Tech Middle School
Billy Chapman, Manual Editor for the TOOL

In "Disrupting Class: How Disruptive Innovation Will Change the Way the World Learns," Christensen, Johnson and Horn (2008) predict radical changes in the way that schooling occurs in the US. The authors predict a sudden, unexpected mass movement of students to commercial educational systems that are better geared to the modern world than is public education. This presentation will demonstrate a powerful knowledge construction TOOL that could be part of the 'modern educational arsenal.' With this TOOL, students are able to obtain the latest information from digital web-based sources; employ natural language processing (NLP) to quickly search many documents; automatically translate the information obtained via NLP into a computer-based knowledge map; use relationship templates to elaborate on concepts and relationships in their knowledge map; attach multi-media illustrations to key concepts, relationships and concept-relationship-concept triplets in their map; and merge their knowledge structure together with those created by other student groups. This TOOL is currently being used worldwide by security agencies and by one American middle school.

S8.3 Strand 1—SC-Paper Set: Representing Matter I

S8.3.1 High School Students' Understanding of Six Chemistry Concepts in Relation to Particulate Nature of Matter and Everyday Phenomena

Zubeyde D. Kirbulut, Middle East Technical University
Michael E. Beeth, University of Wisconsin Oshkosh

This study investigated advanced high school chemistry students' understandings of states of matter, melting, evaporation, condensation, boiling, and vapor pressure in relation to their understanding of the particulate nature of matter using a phenomenological method. A sample of 6 students (4 females and 2 males) enrolled in a second year Chemistry course at a Midwestern high school in the USA was interviewed. Purposeful typical case sampling method was used to identify students who were interviewed for the study. Evidence from these interviews showed how limitations in understanding the particulate nature of matter impacted understanding states of matter, melting, evaporation, condensation, boiling, and vapor pressure. In addition, limitations in understanding the particulate nature of matter also influenced explanations of everyday phenomena held by these students.

S8.3.2 Characteristics and Levels of Sophistication about Mental-Modeling Ability: A Preliminary Study on General Chemistry Students' Thinking Processes with Mental Models of Molecular Geometry and Polarity

Chia-Yu Wang, National Chiao Tung University
Lloyd H. Barrow, University of Missouri-Columbia

This study employed a case study approach to reveal how general chemistry students construct and think with mental models while solving problems about molecular geometry and polarity. Seven student interviews were analyzed to depict features and levels of sophistication regarding participants' mental-modeling behaviors while solving problems associated with spatial information. A protocol composed of four characteristics about mental-modeling ability emerged from the interview analyses that distinguish students in the high, moderate, and low ability groups. Although the levels of mental-modeling abilities are described as categories (high, moderate, and low), they can be thought of as a continuum with the low ability group reflecting students who have very limited ability to generate and use mental models while students in the high ability group not only construct and use mental models, but also evaluate their mental models and monitor their mental-modeling processes. Descriptions on characteristics of mental-modeling ability provide insights for educators and system developers regarding developing computer-based visualization tools to facilitate learning with models and representations. Findings on comparisons across students with different levels of mental-modeling ability have implications for college chemistry instructors about what learning impediments should be addressed while assisting students to learn concepts involving spatial information.

S8.3.3 Reforming the Teaching and Learning of the Macro/Submicro/Symbolic Representational Relationship in Chemical Education

David F. Treagust, Curtin University
John K. Gilbert, Reading University

This research discusses the place of the representational triplet - macro, submicro, and symbolic types - in chemical education. Two sets of emphases have to be met - those intended to develop 'chemical literacy' and those intended as a preparation for the advanced study of the subject – and that the treatment of the representational triplet should be tailored to meet those sets of emphases. It is recommended that emphases given to the triplet relationship in chemistry curricula be in three groups; Learning about the representational levels; Linking understanding at the representational levels; and designing curricula to enhance learning of the triplet relationship.

S8.3.4 A Report of the Ways in Which High School Chemistry Students Attempt to Represent a Chemical Reaction at the Atomic/Molecular Level

Nathan B. Wood, North Dakota State University
Anne L. Kern, University of Idaho
Gillian Roehrig, University of Minnesota

A major challenge in learning chemistry is that the subject necessarily requires an individual to simultaneously negotiate three different "worlds" or representational levels: macroscopic, particulate, and symbolic (Johnstone, 1991). Chemists necessarily navigate these three worlds fluidly, but students are often unaware how, for example, the symbolic representations in a chemical equation are related to observable changes in matter or how molecular formulae are related to bonding in molecules. This study provides a description of the qualitatively different ways high school students attempt to represent the meaning of the symbols in a chemical equation at the particulate level. The large, national-scale sample (n=1337) provides a much broader looking at the variation in students' representations than previous studies.

S8.4 Strand 2—SC-Paper Set: Contextual Factors and Patterns of Representation in Science Classrooms

S8.4.1 Multiple Modes of Self-Assessment in the Inquiry Classroom

Eric M. Eslinger, University of Delaware
Joseph A. Brobst, University of Delaware

This study examines the manner in which middle-school students assess their own work during a ten-week inquiry science classroom unit scaffolded by an interactive learning environment, which was designed to specifically support student self-assessment. We introduce the construct of formative self-assessment, wherein the student not only is the assessor of their own work, but they also are interested in using the findings of that self-assessment to improve their work and learning. Our unique data collection techniques afforded a mixed methods approach to analyzing the problem, coordinating novel representations of keystroke and interaction logs with video captured of every participating student. Students in the classroom significantly improved their inquiry skills. Some, but not all, of the self-assessment analyzed was formative, and we present quantitative and qualitative data that demonstrate the influence of formative self-assessment on learning, and an analysis of the student - teacher - computer - peer interactions that supported and failed to support formative self-assessment episodes.

S8.4.2 Can Learning with Presented and Self-Constructed Visualizations Improve Students Learning from Science Text?

Annett Schwamborn, University of Duisburg-Essen
Hubertina Thillmann, University of Bochum
Claudia Leopold, University of Münster
Elke Sumfleth, University of Duisburg-Essen
Detlev Leutner, University of Duisburg-Essen

This study aims at improving learning with verbal and pictorial representations. It is based on an integration of two approaches to learning with multiple representations. Research on the multimedia approach to learning shows that learning with a combination of verbal and pictorial representations can be beneficial (Mayer, 2001), however, depending on students engagement in active processing. Research on the self-construction approach to learning (van Meter & Garner, 2005) addresses this problem by focusing the strategic processing of the to-be-learned information. Thus, using a 2x2-factorial experimental design with "self- construction" (yes/ no) and "presentation" (yes/ no) as independent variables we examined the effects of self-constructed pictorial representations, presented pictorial representations, and a combination of both on learning from science text. In study 1 we tested under the condition of constant time on task, in study 2 under the condition of self-paced learning time. Results of study 1 revealed significant main effects of self-construction and presentation. Results of study 2 revealed significant main effects of self-construction only. Thus, self- constructing pictorial representations seems to be an effective and efficient strategy for students learning from science text. Results are discussed with respect to the development of a computer-based visualization tool for learning from texts.

S8.4.3 Examining Patterns of Visual Representation Use in Middle School Science Classrooms

Victor R. Lee, Utah State University

We have many reasons to suspect that current patterns of visual representation use in middle school science differs substantially from the ideal. While social studies of science have helped frame understandings of what the ideal with regards to representations could look like, science education research and design also needs a thorough understanding of what activities with representations look like now. This paper intends to contribute to that understanding through collection and analysis of multi-week observations of three middle school science classrooms that were each using different, commercially published light and optics curricula. From iterative review of the resulting video data, 140 episodes of representational use activities were observed and documented. These episodes were analyzed in aggregate for the origin of the representations that were used, the amount of class time that was spent working with those representations, and the frequency of reoccurrence and reuse of previously encountered representational forms. Analyses reveal that most representations that are incorporated in activity are being authored by the teacher, rather than coming directly from the provided curriculum materials. Typical episodes in which a representation is used lasts less than three minutes, and there is a rather limited amount of reuse of previously-introduced representations.

S8.4.4 How Does Limiting Students' Experimental Trials Affect Their Planning, Strategies, and Learning Outcomes?

Kevin W. McElhaney, University of California, Berkeley
Marcia C. Linn, University of California, Berkeley

This study examines the effect of limiting students' experimentation with a dynamic visualization on their planning, experimentation strategies, and learning outcomes. We designed a week-long, technology-enhanced inquiry module on car collisions. The module uses new technologies that log student interactions with the visualization. Physics students (N=58) in two high schools were assigned to one of two comparison conditions: constrained (students were instructed to conduct a specified number of experimental trials) and unconstrained (students conducted as many trials as they wished). Students responded to pretests, posttests, and embedded assessments on motion and controlled experimentation. We scored students' experimentation for how well they isolated variables that corresponded with their chosen investigation questions. Students made significant overall pretest to posttest gains. Although constrained students isolated variables in their experiments better than unconstrained students, the constrained students significantly underperformed the unconstrained students on subsequent physics assessments, indicating that isolating variables during experimentation did not lead to improved learning outcomes. The findings suggest that guidance designed to promote the planning of controlled experiments may direct students' attention to the conditions of experimentation but does not necessarily improve their understanding of the experimental situation.

S8.5 Strand 3—SC-Paper Set: The Use of Dialogue and Questioning to Promote Learning in Primary Science

S8.5.1 "More Table, Less Carpet!": The Transformative Role of Cogenerative Dialogue And Video Analysis on Science Teaching and Learning in the Elementary Classroom

Sonya N. Martin, Drexel University
Christina Siry, CUNY

This study examines the role of cogenerative dialogue (Tobin & Roth, 2006) in the elementary classroom as an approach to create participatory discourses with children and teachers. Conducted within the methodological and theoretical frameworks of critical ethnography, this study employs novel research methods to examine the teaching and learning of science in urban elementary classrooms in which the teachers and their students engage in classroom research. In this project, teachers and students collaborate to employ cogenerative dialogue and video analysis as tools to help them examine and discuss how they interact in the classroom and how these interactions shape the teaching and learning of science. The primary goal of this research is to transform science education by examining the social and cultural interactions between classroom participants and to examine the use of cogenerative dialogue and video analysis as tools to support teachers in learning about children's understandings in science. By eliciting students' ideas, and then enacting changes in the classroom, this research seeks to support teachers and students to transform science teaching and learning in the early grades.

S8.5.2 Sociocultural Influences on Primary Science Pedagogy: A Multilevel Analysis of the Effect of Questions/Questioning

Diane P. Harris, University of Manchester, UK
Julian S. Williams, University of Manchester, UK

UK science educationalists assert that teachers should ask 'open' questions to elicit pupils' ideas relevant to the science being taught. In contrast, some educational psychologists believe that young children can be confused by open questions and argue that children's cognitive potential can thereby be seriously under-estimated. Alternatively, a sociocultural perspective suggests the importance of background social factors in evaluating discursive interactions. This paper analyses teachers' questioning practices in twenty primary schools which serve very diverse communities in England: patterns of questioning in regard to age and subject are explained by an 'acculturation' model. However, discourse microanalyses of some anomalous cases reveal that 'context' (exophoric and anaphoric) of utterance is more relevant than its 'internal grammar' (i.e. 'open' versus 'closed') in explaining its function, and so the pedagogic 'code' (Bernstein). To test this hypothesis, multilevel modelling is used to analyse the survey data set of questions and responses (N=5000 question-response pairs in 102 classroom activities) in science versus literacy activities with children aged from three to nine years. The resulting model reveals the effect of the 'subject', age-level and the socio-economic status of the school on the patterns of question-response interaction: and hence of 'class' on Bernstein's 'pedagogic code'.

S8.5.3 Data and Claim: The Refinement of Science Fair Work through Argumentation

Jian-Jung Chen, National Dong Hwa University, Taiwan
Huann-Shyang Lin, National Sun Yat-sen University, Taiwan
Ying-Shao Hsu, National Taiwan Normal University
Huei Lee, National Dong Hwa University, Taiwan

This study adopt case studies with the help of open-ended questionnaires, pupils' notes, teacher's journals, works of science fair, photos, videos and other materials in order to explore argumentations that will promote the elaborating process of inquiry. The participants in this study are 6th grade pupils from 4 different classes, composed of 5 girls and 2 boys. 5 out of the 6 participants were volunteers in the 5th grade science activities conducted by this researcher last year. That particular activity included reading, experiments, observations, craft bulletin and other written materials, report, and discussion activities. The remaining student joined the study one semester later. The results of this research showed that rebuttals are not evident in scientific projects, the data, claim, and warrant are key elements of elaborating process in science fair, but it's meaning are not easily understood by primary students, and teachers are required to continuously explain the importance of argumentation. The act of formulating conclusions based on empirical data is difficult for students. They find it less complicated to inspect empirical data based on conclusions.

S8.5.4 The Impact of Technology-Enhanced Instruction on English Language Learners' Science Learning

Kihyun Ryoo, Stanford University

Learning science is already demanding for most students, but the challenges that English Language Learners (ELLs) face are more serious because they are still developing English proficiency. Even after they are able to carry out conversations in English, they may lack academic English skills necessary to engage in science subjects. This study examines the impact of teaching scientific concepts in everyday English prior to introducing scientific language on ELL's understanding and use of scientific language, compared to proficient English-speaking (PE) students. The 134 5th grade students were randomly assigned to a treatment group where they learned scientific concepts in everyday English before learning scientific language or a control group where students studied the same concepts in everyday and scientific language simultaneously. The results reveal that both PE students and ELLs in the treatment group significantly outperformed their counterparts in the control group on multiple-choice and open-ended tests, and there were no significant achievement gaps between them. The analyses of students' written and spoken discourse show that the treatment group demonstrated a greater ability to provide more detailed and complete understanding of the science content and used more appropriate scientific language associated with the correct scientific concepts than the control group.

S8.6 Strand 4—Strand Invited Symposium: Inquiry Science Instruction or Direct? Experiment-Based Answers as to what Practices Best Promote Conceptual Development of Significant Science Content

William W. Cobern, Western Michigan University
David Schuster, Western Michigan University
Reneé S. Schwartz, Western Michigan University
Janice D. Gobert, Worcester Polytechnic Institute

The science education community has overwhelmingly adopted a guided-inquiry perspective on science teaching. Nevertheless there remains debate about instructional approaches across a spectrum from direct through guided inquiry to open discovery. Questions about the efficacy of inquiry-based instruction linger. Proponents point to supportive studies, but critics counter that little of this research is sufficiently controlled. In various states there is political pressure for a return to direct instruction. The lack of convincing research for inquiry is thus of concern, hence with NSF/IERI funding we executed a 4-year experimental study with randomized subjects to test the efficacy question with regard to science conceptual development. In this symposium we describe the project, present and interpret the findings from both cognitive and practical perspectives.

S8.7 Strand 5—Related Paper Set: Mutually Exclusive to Synergistic: Factors Affecting Integration of Teaching and Research in Higher Education Faculty and Graduate Students

S8.7.1 The Great Debate: The Value of Teaching and Research in Graduate Student Research Skill Development

Denise C. Strickland, University of South Carolina
Briana E. Timmerman, University of South Carolina
Michelle Maher, University of South Carolina
David Feldon, Washington State University

Little is known about the nature and developmental trajectory of scientific expertise in science and engineering graduate students (Davis & Fiske, 2001; Gaff, 2002), specifically whether and to what extent students' participation in teaching and/or research influences developing research skills. This study uses a multi-disciplinary multi-method approach to connect graduate students' insights about their research skill development to an objective, rubric-driven perspective on research skill level. Results indicated that participation in research assistantships, year of matriculation, involvement in publication, and stability of research agenda were most highly related to students' research skill development. The effects of teaching on students' research skill development appear to be more subtle. A notable trend was the emergence the effect of audience on graduate students' understanding of their research. For a minority, the acts of translating and/or explaining their research to others stimulated reflection or insight which facilitated their research programs. Implications for graduate education and research scientists, as well as college science teachers are discussed.

S8.7.2 Do Research Experiences Enhance the Inquiry-Oriented Teaching Skills of STEM Graduate Students?

Cindy Stiegelmeyer, University of South Carolina
David Feldon, Washington State University

Faculty often view teaching and research as competing priorities of which teaching is the less valuable (Bianchini et al., 2001). This adversarial relationship typically stems from the assumption that the required skill sets for teaching and research are unrelated (Hattie & Marsh, 1996; Seymour, 2001). However, this assumption has rarely been tested or empirically confirmed. This study reports quantitative and qualitative data which suggest that participating in research experiences actually enhances the development of graduate students' inquiry-based teaching skills. Participants' teaching skills were assessed using RTOP rating of videotaped lessons, students reported experiences, and semi-structured interviews with participants. Participants engaging in concurrent research and teaching experiences significantly improved their inquiry-oriented pedagogical skills over the course of an academic year and did so with significantly higher gains than participants in a comparison group who taught but did not also pursue research activities.

S8.7.3 Exploring the Professional Identity Formation of Teachers

Joanna Gilmore, University of South Carolina
Melissa Hurst, University of South Carolina
Michelle Maher, University of South Carolina

Much of the science education community now advocates for a new vision of instruction emphasizing inquiry-based teaching (National Research Council, 1996). Unfortunately, as Anderson (2002) notes, many science teachers are not adopting reformed teaching practices. To facilitate the adoption of reformed teaching, Luehmann (2007) argues that teacher education must address the development of professional identity. Unfortunately, little is known about the knowledge, beliefs, values, experiences, and ways of acting and interacting that graduate students in science and related fields bring to their studies. Through interviews with 19 graduate students who taught science and related disciplines, this study reached generalizations about the developmental trajectory of science educators' professional identity. In general, less experienced teachers focused on personality characteristics in describing their identity and they viewed coursework and childhood experiences as particularly influential in learning how to teach. Experienced teachers often described themselves in terms of ability to adjust instruction and connect with students. They often drew upon professional development experiences and collaboration in learning how to teach. This study also found that participants' co-teaching experiences positively impacted their self- views as reformed teachers. The study reflected previous conceptualizations of teacher development put forth by Fuller and Bown (1975) and Ryan (1986).

S8.7.4 Exploring the Professional Identity Formation of Researchers

Melissa Hurst, University of South Carolina
Joanna Gilmore, University of South Carolina

This study explores factors shaping the development of graduate students' professional research identity in science, technology, engineering, math and education disciplines. Informed by qualitative data, this study attempted to conclude generalizations about the development of graduate researchers. Finding connections between the research identities and the experiences impacting the student researchers is fundamental to the development of student's professional research identity. Study results suggest that graduate researchers generally learn about conducting research through interactions with advisors/mentors and being part of a research community of practice. Students often drew upon professional development experiences and collaboration with students and professional researchers to improve their researching skills. Implications of these findings as they pertain to doctoral education across academic disciplines are advanced.

S8.7.5 Finding Connections between STEM Graduate Students' Teaching and Research Identities and Skill Sets

Michelle Maher, University of South Carolina
David Feldon, Washington State University

This paper, the capstone in our related paper set, synthesizes findings from the four previous papers to examine the nature and extent of connections across graduate students' emergent identities as teachers and as researcher, and between their developing teaching and research skill sets. Drawing from an analysis and interpretation of a complementary dataset inclusive of rubric-driven research proposal outcomes and videotaped and rated classroom teaching observations, combined with data from perceptual surveys and narrative repeated in-depth interviews, our findings provide rich insight into the developmental trajectory of teaching and research identity and skills of approximately 20 graduate students from science, technology, engineering, math, and science education (STEMED), most of whom intent to pursue a faculty career. Our combined findings suggest that teaching and research identities share common characteristics in their development, and that under certain conditions, graduate students who engage in teaching may show improved research skill outcomes, while those who engage in research may show improved teaching skill outcomes. We present implications of these findings for graduate education and research scientists, as well as college science teachers.

S8.8 Strand 6—SC-Paper Set: Scientists, Citizens, and Learning Science Beyond School

S8.8.1 Reflections of Scientists and Engineers: Developing a Sense of Scale

M. Gail Jones, NC State University
Amy R.Taylor, University of NC at Wilmington

Although scale has been identified as one of four major interdisciplinary themes that cut across the science domains (American Association for the Advancement of Science, 1989), we are only beginning to understand how expertise in learning and applying scale develops.

This study sought to understand how expertise in scale develops from childhood to adulthood by asking 50 professionals to reflect on their experiences (in and out-of-school) learning about scale. Semi-structured interviews were utilized to obtain information about educational experiences, out-of-school (informal) experiences, and applications of scale in different professions. Results showed that most of the participants used mental anchor points as conceptual benchmarks when applying scale in their job. Seventy-six percent of the participants attributed physical experiences such as moving through the environment by car, walking, bicycling, boating, or flying in an airplane as contributing to the development of a sense of scale. Results of this study were used to develop a trajectory of scale concepts that develop as individuals move from novice through increasing degrees of expertise. Across professions, participants emphasized the critical role that scale plays in their work. For many, scale was viewed as central to accomplishing the work-related tasks.

S8.8.2 Citizen Science: Positioning the Citizen in Environmental Monitoring and Informal Science

Carol B. Brandt, Virginia Polytechnic Institute & State University
Jane Lehr, California Polytechnic State University
Nancy McCrickard, Virginia Polytechnic Institute & State University

In their book, Rethinking Scientific Literacy, Roth and Barton (2004) argue that scientific literacy may be more effectively conceived as "citizen science" in which science connects to the immediate interests of people as they go about their everyday lives. These authors describe citizen science as situated in people's lives and existing through a variety of participatory modes. Our presentation consists of two parts: first, we explore competing constructions of scientifically literate citizenship in citizen science programs to show how this concept is socially and politically shaped. We also examine how the "citizen" is variably positioned within the framework of scientific inquiry. Second we provide case studies of a river watershed in southern Virginia and three biological monitoring programs as examples of scientifically literate citizenship with a focus on the various ways that the citizen is located in the framework of these projects. The goal of this presentation is to bring a critical awareness of how the public is variably positioned in citizen science and often distanced from meaningful participation in issues that directly impact their lives.

S8.8.3 Identity and Science Learning in Informal Learning Environments

Sylvia M. James, National Science Foundation
Karen Benn Marshall, Montgomery College

Many afterschool programs focus on reading, mathematics, or homework assistance, using either an explicit or embedded approach to address academic content. However, in recent years afterschool providers are finding that they can also offer students high quality, hands-on science experiences. The Report of the 2000 National Survey of Science and Mathematics Education states that K-3 teachers spend only 23 minutes per day on science instruction (Weiss, Banilower, McMahon, & Smith, 2001). Consequently, educators and policymakers have come to the realization that increasing student science achievement may require partnerships between schools, community organizations, and informal science education institutions such as museums and science centers, as well as afterschool programs to augment science lessons. This paper provides an overview of research findings on learning science outside of the classroom, with an emphasis on the role of identity and science learning. Increasingly, educators and policy makers recognize that more time is needed to prepare students to be effective in the 21st century workforce. Research and program evaluations suggest that afterschool programs not only supplement school science, but also are sometimes more effective than traditional science classes in providing students with opportunities to engage in self-directed learning while nurturing their identities as science learners.

S8.8.4 Scientific Literacy: College Student's Evaluations of Scientific Media Reports

Cassandra A. Jones, Grande Prairie Regional College
Connie Korpan, Grande Prairie Regional College

The ability to read and critically evaluate information in media reports of scientific research is an important skill for citizens in today's society. When reading research conclusions reported in the media, literate individuals are able to identify and consider a variety of research features. Such features include credentials of the researchers, the researchers' theory, methods used, evidence collected, etc. In this study, 83 high school students and 78 college students were given a Cued Task in which they were presented with four news reports about scientific research; they rated each conclusion before and after being provided details about the underlying research and identified the scientific nature of sentences embedded in the news reports. Students' performance on the Cued Task was not always consistent; each task tapped into different types of knowledge and competencies. The ability to identify most research features (theory vs. evidence) improved with formal science training. However, many of these skills were lacking in both high school and college students. High school students appeared to have the most difficulty categorizing statements referring to the Source of Information (where information is published) and Theory/Explanation. College students exhibited similar difficulties categorizing Theory/Explanation statements, often confusing these statements with Evidence/Data or Researchers' Conclusion.

S8.9 Strand 7—SC-Paper Set: The Role of Identity and Emotions in Preservice Teacher Education

S8.9.1 Ways of Knowing Science: Identity Development in Prospective Elementary Teachers

Laura L Creighton, Rhode Island College

Research suggests that subject matter is an important context for elementary teachers' work and identity construction. However, a fully developed and powerful understanding of what it means to incorporate the self in learning and teaching has yet to be developed. This research contributes to our understanding by applying views of knowledge and learning to how we think about preparing teachers. Using ethnographic and discourse analytic techniques, I describe the ways prospective elementary teachers came to know science and how that impacted their developing senses of self as "science people"—people who enjoy, view themselves as capable of and who engage in the practices of inquiry-based science. How the participants viewed themselves as science people influenced how they defined their responsibility, their capability and their enthusiasm for teaching inquiry-based science.

S8.9.2 Retrospective Testing and Science Teaching Self-Efficacy: The influence of context

Richard P. Hechter, University of North Dakota

This study investigated how retrospective-test / post-test perceptions of science teaching self- efficacy differ according to personal science teaching expectancy (PSTE) and science teaching outcome expectancy (STOE) among preservice elementary teachers when exposed to a science teaching methods course. Preservice elementary teacher candidates (N=87) enrolled in 2007 and 2008 sessions of an elementary science methods course reported their science teaching self-efficacy through the Science Teaching Expectancy Belief Instrument (STEBI-B). The survey was administered three times using pre-test, post-test and retrospective-test methodology. With the psychosocial construct of self-efficacy as the framework, responses were placed in context to provide statistical and practical insight into the research questions. Findings revealed that whether preservice elementary teachers met or exceeded the number of postsecondary science courses required to graduate, and their positive or negative perceptions of prior school science experiences had a statistically significant main effect on the change in PSTE but not STOE. There was no evidence to suggest significant interaction effects of number of postsecondary science courses taken and perception of school science experiences on the change in both PSTE and STOE. The implications of this study have bearing on current and future organization, structure, and dynamics of elementary science teacher preparation.

S8.9.3 Pre-Service Elementary Teachers' Anxiety about Teaching Science: What are the Triggers?

Nejla Yuruk, Gazi University
Pinar Akgul, Gazi University
Meryem Demir, Gazi University

The aim of this study was to investigate the degree and the nature of the relationship between pre-service elementary teachers' anxiety about science teaching and their self- efficacy beliefs about science teaching, their perceptions of the nature of past experiences in science teaching, the number of science courses they took in college and their previous grades in these science courses. The data was collected from 82 pre-service elementary teachers enrolled in an M.Ed program. The collected data was analyzed by bivariate and multiple regression analysis to get an idea about the nature of correlations among the variables considered in this study. In order to compare science teaching anxiety of pre- service teachers who had no experience, positive experience and negative experience in science teaching ANOVA was generated. The results indicate that personal science teaching efficacy and number of science courses taken in college are the significant predictors of science teaching anxiety. Pearson correlations among the variables show that their perception of their experiences in science teaching, grade point average of science courses and perception of science background indirectly influence science teaching anxiety. However, the effect of these variables on science teaching anxiety was mediated by personal science teaching efficacy in the simultaneous multiple regression model.

S8.9.4 The Emotional Ecology of Becoming an Urban Science Teacher: Intersections between Identity, Emotions, and Explicit and Implicit Motivation

Maria S. Rivera Maulucci, Barnard College, Columbia University

This qualitative study is a part of a larger, ongoing study aimed at exploring interactions between teacher identity, learning, and classroom practices in a social justice teacher education program at a selective liberal arts college in New York. This case-study explores Elena's journey towards becoming an urban science teacher. Elena reflects upon her learning in a science methods course, her learning in a social justice teacher education program, and her field experiences in elementary dual language classrooms. The analysis spans macro, meso, and microlevels to explore the intersections between language, identity, and emotions and Elena's explicit and implicit motivations as they unfold in science classrooms. The findings show some of the linkages between Elena's explicit and implicit motivations and her conceptual development as they unfold through the activities of curriculum development and teaching in dual language science classrooms.

S8.9.5 Examination of a New Model of Science Teacher Identity (STI) among Pre-Service Science Teachers

Hyun Jung Chi, The Ohio State University
David L. Haury, The Ohio State University

In this study, a new conceptual model of Science Teacher Identity (STI) was proposed and examined to explore the dimensions of STI and to determine whether the level of science teacher identity can be measured. For this study, a 48-item questionnaire was developed using a Likert format to measure the nine dimensions of the model: science teachers' personal learning experience, having knowledge and skills, community practice, science teaching practice, degree of success, social respect, belief and value in science teaching, intrinsic satisfaction, and representation. To test the model, the nine dimensions of STI were quantitatively and qualitatively studied with 20 preservice science teachers within the context of a graduate level science teacher preparation programs using a survey, interviews, and an examination of academic work. The scale scores and correlations of each dimension of STI were investigated using data from a survey of 365 science teachers. The reliability and validity of the questionnaire were analyzed. The results of this study provided evidence that the of construct science teacher identity can be explicitly defined and reliably measured and that the changes of STI dimensions can be predicted in relation to professional development programs and professional experiences.

S8.10 Strand 8—SC-Paper Set: Early Career and Mentoring

S8.10.1 Mentoring New Mentors: Classroom-Based Learning Experiences for Science Teachers

Rebecca M. Schneider, The University of Toledo

Educational programs need to engage science teachers in learning as professionals. This includes experiences grounded in classroom practice and guidance to develop as professionals so science teachers can take on roles of leaders in their classrooms and in partnerships with universities. Based on ideas about how teacher learn, an innovative set of graduate courses for science teachers hosting a preservice candidate was designed to support teachers in learning about reform-oriented practices and how to provide educational experiences for candidates. Web-based communication tools were used to encourage collaboration and enhance the learning environment for science teachers. A total of 26 science teachers participated in course one and nine teachers continued in course two. Data were examined for evidence of teachers' thinking about science teaching and mentoring novices, using pedagogical content knowledge (PCK) and teacher educator's PCK in science as a framework to guide analysis. Findings indicate that when teachers focused on what candidates are expected to learn and how to support their efforts, they reconsidered their own teaching and became thoughtful about mentoring. Findings also indicate that learning to mentor well is challenging; teachers need time and continued support as they develop as mentors and partners in science teacher education.

S8.10.2 Increasing the Efficacy, Instructional Skills, and Effectiveness of New Science Teachers: What the Data Tell Us Works

Donna R. Sterling, George Mason University
Wendy M. Frazier, George Mason University
Mollianne G. Logerwell, George Mason University

This four-year study examined the effect of various support factors on the success and retention of uncertified, in-service middle and high school science teachers. Using a quasi- experimental treatment-control group design, 53 beginning teachers were randomly assigned to a treatment or control group. The New Science Teachers' Support Network (NSTSN) provided three cohorts of treatment teachers with multiple supports for two years including science methods courses, in-class coaching support by retired science teachers, a website, and mentoring by fellow teachers and science professors. Data were collected through online surveys, interviews, focus groups, observations, state science achievement test scores of 5,839 students in the participating teachers' classrooms for which a state- administered standardized test was offered, and science course grades of 10,367 students in the participating teachers' classrooms. Major significant findings include: (1) treatment teachers' instructional skills improved over their two years in the program, (2) treatment teachers' students outperformed control teachers' students both in terms of course grades and on state standardized tests in several subject areas, and (3) the teachers' teaching efficacy fluctuated during their two years in the program.

S8.10.3 Linking Teacher Outcomes to Learning Opportunities in a Science Teacher Induction Program

Jamie N. Mikeska, Michigan State University
Jeffrey J. Rozelle, Michigan State University
Jodie A. Galosy, Michigan State University
Suzanne M. Wilson, Michigan State University

This analysis is part of a larger study, the purpose of which is to examine the impact of science-specific professional development (PD) on novice science teachers' learning and their students' learning and engagement. The goal of the analysis described here is to determine how various teacher outcomes are linked to PD. To explore these links, we developed methods to characterize each teacher's individualized program experience, identified specific patterns of PD, and documented multiple teacher outcomes (e.g., teachers' knowledge and classroom practice). Parsing the influence of induction components is particularly challenging given the context of our study, a two-year Beginning Teacher Induction Program (BTIP) that offers varied support structures including a summer institute, Saturday workshops, mentoring, coaching, a curriculum library, and listservs. Each teacher chooses among program features to create his or her own version of induction support. In this paper, we describe a method for representing individual teacher's learning opportunities within the BTIP, discuss how we use these representations to identify teachers' pathways in the BTIP, explore how teachers' background characteristics and contexts contribute to these pathways, and link teachers' knowledge and practice to their BTIP participation.

S8.10.4 Enactment of Reform in Induction: Changes in Beginning Science Teachers' Self-Efficacy Beliefs and Pedagogical Discontentments

Yavuz Saka, Florida State University
Sherry A. Southerland, Florida State University
Barry W. Golden, Florida State University

The first years of teaching are demanding as the novice works to gain a degree of familiarity in her/his professional work. It is during this period that many teachers decide to leave the teaching profession or move away from the reform-minded practices acquired during their teacher preparation programs. By focusing on cognitive and contextual issues related to science teaching the goal of the broader qualitative, multicase study was to describe two reform-minded teachers' induction experiences and the strategies they used to negotiate contradictions embedded the context of schooling. In this aspect of the broader study, we focused on changes in science teachers' self-efficacy and pedagogical discontentment and how these were influenced by context and shaped their teaching practices. Data included participant and classroom observations, surveys, open-ended questionnaires, interviews and documents. Changes in these teachers' self-efficacy beliefs and pedagogical discontentments played important significant role in beginning science teachers' attempts to become competent members of their school communities, as well as their enactment of reform in their first year teaching. Mild contradictions in the system allowed for the refinement of reform-minded practices, while extreme contradictions served to change one teachers' goal and moved him away from the goals of reform and his first year school.

S8.11 Strand 8—SC-Paper Set: Approaches to Continuing of PD

S8.11.1 Project SLICE: Science Learning Through Inquiry, Content, and Engagement

Norman G. Lederman, Illinois Institute of Technology
Judith S. Lederman, Illinois Institute of Technology
Gary M. Holliday, Illinois Institute of Technology
Kevin J. White, Illinois Institute of Technology

Project SLICE is an ambitious systemic professional development initiative designed to enhance high school students' achievement in biology, chemistry, and physics (grades 9-11) through extensive curriculum support and continuous on-site and off-site professional development support for teachers. Scientific inquiry and nature of science provided coherent themes for curriculum support and the design of the project provided a context for the collaboration of science teachers, scientists, engineers, and science educators. Project SLICE currently involves all biology, chemistry, and physics teachers in 20 high schools and each school is engaged in the project for three years. There are currently 164 participant teachers and 24,652 students involved in the project. The results for the first three years of the project indicate that students have made significant gains in their understandings of subject matter (i.e., biology, chemistry, physics), as measured by standardized tests, understandings of scientific inquiry, and understandings of nature of science. Teachers have shown increasingly sophisticated understandings of scientific inquiry and nature of science, and their ability to teach subject matter, scientific inquiry, and nature of science. The data clearly indicate that both students and teachers improve their knowledge and skills with increasing years of engagement in the project.

S8.11.2 New Approaches to Primary Science Teaching and Assessment (NAPSTA) CPD programme

Karen M. Kerr, St. Marys University College Belfast
Colette Murphy, Queens University Belfast
Jim Beggs, St. Marys University College Belfast

This paper reports on the design, implementation and findings from an innovative continuing professional development (CPD) programme, New Approaches to Primary Science Teaching and Assessment (NAPSTA). The NAPSTA programme addresses the grand challenge of equipping teachers and student teachers with novel, creative and exciting ways to teach science. The introduction of a Revised Curriculum in Northern Ireland (September 2007) has placed emphasis on greater teacher autonomy with regard to planning classroom experiences. It thus provides a great opportunity for teachers to experiment with content and approaches to science teaching. The NAPSTA programme was delivered to both in-service and pre-service teachers, who together implemented the new approaches to science teaching in the classroom via coteaching (proposal authors 2004). This presentation will describe the NAPSTA CPD workshops and ways the pre-service and in-service teachers worked together to maximise implementation of these approaches. Data was collected using a variety of different instruments: attitudes audits, reflective diaries, lesson photographs/videos, interviews and focus groups. The findings present evidence for increased engagement and enjoyment and greater confidence in implementing creative approaches to primary science teaching and assessment. The majority of teachers also talked about a shift from traditional teaching approaches to shared ownership of lessons.

S8.11.3 Teaching and Learning Science with Geospatial Technology: The Impact of Flexibly Adaptive, Long-Term Professional Development on Teachers and Students

James G. MaKinster, Hobart and William Smith Colleges
Nancy M. Trautmann, Cornell University

GT-Science (pseudonym) is an ongoing professional development program for middle and high school science teachers focused on enabling them to use geospatial technology to teach science and allow their students to see geospatial technology as tools for exploring scientific questions. This study examines the impact of this experience on participating teachers and their students. Results demonstrate the transformative potential of a professional development model that reflects best practices and forwards being flexibly adaptive as an additional dimension for science educators to consider in designing programs to help teachers use technologies for a wide range of curricular goals. Questionnaires, teacher reflections and teacher-designed curricular materials demonstrate the impact of this professional development experience on teacher perceptions, ability, and teaching practices.

S8.11.4 Building Science Content Knowledge through Sustained Professional Development

Kimberly A. Lebak, The Richard Stockton College of New Jersey
Norma J. Boakes, The Richard Stockton College of New Jersey

The purpose of this research is to study the effect a professional development institute has on the development of standards-based instruction for teachers of science and mathematics in grades 3-8. This study is part of a larger on-going three year program, funded by the United States Department of Education, designed to increase student achievement in science through sustained professional development. Forty-four teachers participated in a two-week long professional development institute intended to increase teachers' content knowledge in life science. Mathematics and technology was integrated within the life science study. Data collection included pre and post tests, concept maps, and participant generated units of study. This research provides evidence that sustained, focused professional development can increase the content knowledge of classroom teachers and can directly translate to standards based instructional practices.

S8.12 Strand 9—SC-Paper Set: Reflective Practice

S8.12.1 Professional Development through Action Research: The Development and Use of a Learning Environment Questionnaire as a Tool for Reflection

David Wood, Curriculum Council of Western Australia
Jill M. Aldridge, Curtin University of Western Australia
Barry J. Fraser, Curtin University of Western Australia

This paper reports the development and validation of an instrument designed to provide science teachers with information, based on students' perceptions, about their classroom environments. The instrument is designed primarily to provide teachers with a tool that can

be used as a basis for reflecting on their teaching practices and, in turn, guiding the development and implementation of strategies to improve their learning environments. To describe the reliability and validity of the new instrument, data from 2043 student responses from 147 classes in 9 schools were analysed. In addition, three case studies were used to examine the usefulness of student responses to learning environment questionnaire as a tool for reflection and a guide in transforming their classroom environments. These case studies (one of which is described in this paper) helped to determine the extent to which action research based on students' perceptions of the learning environment was useful in guiding teachers' improvement of their classroom learning environments.

S8.12.2 Prototypical Routines of Biology Teachers

Martin Linsner, University of Duisburg-Essen, Germany
Philipp Schmiemann, University of Duisburg-Essen, Germany
Angela Sandmann, University of Duisburg-Essen, Germany
Birgit J. Neuhaus, Ludwig-Maximilian-University of Munich, Germany

Programs to increase the quality of education point out consistently that an improvement of instruction is determined by strengthening teachers' professional development (Terhart, 2000). Confronting teachers with findings from educational research usually does not affect their cognitions. A well known way to influence teachers' cognition is to make them reflect on their own classroom practice. In this study a pedagogical tool (CD-ROM) was developed, suitable for in-service teacher trainings. By the use of this pedagogical tool, biology teachers will be able to identify and reflect their own prototypical routines. Therefore science-specific prototypical routines concerning the entrance into a lesson, behavior in experimental situations and handling students' misconceptions were identified. Three types of prototypical routines could be identified by cluster analysis. To know biology-teachers' prototypical routines will help to instruct them adequately in pre-service and in in-service teacher training programs so that teaching skills can be improved individually.

S8.12.3 Enacting Reflections on Practice in Preservice Science Middle School Teachers

Teresa Jimarez, Texas A & M Universty

The nature of science preservice teacher knowledge with respect to practice has been studied to improve teacher preparation programs in hopes to improve teaching practices, but most importantly student achievement. One of the problems we face as pre-service teachers (PST) instructors is to direct instruction to help students develop a reflective process to critically analyze field experiences and ultimately their own practice. This study is a longitudinal self study of two consecutive semesters of PST training enrolled in my middle grades science methods course. The subjects of this study were 73 students, of which 67 were females and 6 males. A qualitative methodology was employed to examine PST written pieces of work of online responses to guiding questions and summary reflections of field based observations, journal reflections, and streaming video reflections. This study suggests that in order to develop a reflective process to analyze teaching practices, PST need to be provided with ample opportunities to develop this process to gain an understanding of how inquiry based practices when anchored in a student centered philosophy promote meaningful learning which has proven to increase student achievement in science (Jimarez, 2005).

S8.12.4 Using Cogenerative Dialogues to Facilitate Agency in Science Methods Courses

Line A. Augustin, Queens College City University of New York

This paper presents the rationale for using cogenerative dialogue as a tool to improve student learning by facilitating the enactment of collective practices as a strategy to improve collective agency, and thereby, improve classroom learning. My findings reveal that the use of cogenerative dialogue provides structure for enactment of practices, which often increase the likelihood of students expanding their classroom roles from peripheral participation to central forms of participation in my science methods classes. The study focused on the extent to which culture produced in cogenerative dialogues were used as seedbeds for the growth of culture that can be transferred by teachers and students into their science classes, thereby improving the quality of science education. Students had a reverse disposition towards science and teaching science after they were able to take part of the teaching and learning process. The dialogues give them the space to express their concerns, satisfaction, frustration, needs, successes and the possibility to be active contributors of the structure of the class. This study demonstrated how cogenerative dialogue can serve to catalyze successful peer interactions, building confidence and good disposition for science education and a deep sense of ownership of the learning process.

S8.13 Strand 10—SC-Paper Set: Validity and Absence-of-Bias of Standardized Measurement Instruments

S8.13.1 Rising Questions of Validity of Translated Science Units from PISA

Alice M. Rodrigues, University of Lisbon
Mauricia M. Oliveira, University of Lisbon

In a European country, during the development of a research study it was needed to assess pupils' scientific literacy. Consequently, it seemed quite natural to constitute a pool of science activities based on the translated science units used by PISA and then, to search evidence that the activities were still valid for the purpose of the study. During the process of validation a team of ten university experts, several science middle school teachers and 124 pupils from six 9th grade classes of four schools collaborate. Several questions arose regarding the validity of the translated version. For example, the readability and comprehension levels of the science units; the lack of accuracy of scientific terminology; different meanings for the same terms in scientific language and in common language; the pupils' non-proficiency in the official school language or, as the cultural context is different, the units no longer testing scientific literacy but instead just common knowledge were some of the issues that we dealt with. Implications for scientific literacy assessment can be drawn for international studies where validity evidence comes from a population that is not similar to the population from which the sample was constituted.

S8.13.2 Exploring Differential Item Functioning (DIF) in the Measurement of Student Knowledge and Misconceptions of Natural Selection

Ross H. Nehm, The Ohio State University
Judy Ridgway, The Ohio State University
William Boone, Miami University

Two instruments (the CINS and ORI) have been developed by the science education community to measure knowledge and misconceptions of natural selection. Neither instrument has been evaluated for Differential Item Functioning (DIF) with respect to race. This is concerning given that the study of DIF is a central component of instrument development according to the Standards for Educational and Psychological Testing. DIF is important for two simple reasons: First, it may be used to uncover biased instrument items; second, it may be used to inform instructional practice through the identification of knowledge differences between groups. Our analysis of under-represented minority and traditional biology majors' performance on the CINS instrument revealed that item 12 displays significant DIF. Additionally, our analysis of biology majors from a minority serving institution and those from a Midwestern research university revealed numerous items characterized by DIF (6/20 items). These results raise the question of whether particular CINS items display racial bias or whether particular racial groups harbor different funds of knowledge and misconception magnitudes. Further research will be required to answer this important question.

S8.13.3Evidence of Student Thinking in the Validation of Science Assessment Items: Confirming Student Idea Use

Robert J. Ochsendorf, George Washington University

This paper explores the extent to which seven paper and pencil assessment items judged by experts to be aligned with forces and motion ideas actually measure those concepts for middle school students. To accomplish this, the paper compares students' individual responses under paper and pencil and interview conditions while considering an elaborated model of a target science idea assessed by the items. The paper seeks to confirm the inferences provided by a written science assessment instrument by comparing them to alternative inferences based on student interview data. Participants in the study were a diverse sample of 14 middle school students. Each student completed the written assessment instrument and then participated in an interview designed to confirm student idea use. All interview transcripts were coded for idea use and the results from coded data were then compared to students' performance on the written posttest. The paper concludes that in most cases, the two sets of assessment evidence were in agreement and that the items provide valid inferences about students' actual understanding of the target ideas. The study also concludes that on a few occasions the written posttest overestimated students' performances when compared to data collected during the interviews. The study presents additional student ideas regarding forces and motion that have been previously undocumented in the literature. Conclusions and implications are discussed.

S8.13.4 Considering Construct Validity in Assessment Construction: The Case of the Test of Astronomy Standards (TOAST)

Stephanie J. Slater, University of Wyoming
Timothy F. Slater, University of Wyoming

Construction of a valid and reliable, criterion-referenced course survey, suitable as either formative assessment or research instrument, is a challenging and lengthy task, and can serve as a barrier to quality research. We found that constructing assessments with an emphasis on construct validity, accelerates that process while simultaneously increasing the quality of the final instrument. We are defining construct validity as a judgment of the extent to which a measurement taken by an assessment matches the theoretical account of students' conceptual understanding as reported in the literature. In the creation of the Test of Astronomy STandards (TOAST), we aligned the existing results and instruments from science education research and a consensus of learning goals suggested by the astronomy community. We found many of the issues associated with measures of validity as defined by Classical Test Theory were effortlessly resolved. Test items were statistically robust and the test demonstrated a high degree of internal consistency. More importantly the assessment made sense qualitatively, with an analysis of each item showing strong construct validity. Our methodology did not require learning sophisticated statistical techniques, but knowledge of the research and instruments available in our field: something most instructors and researchers already possess.

S8.14 Strand 11—SC-Paper Set: Learning to Participate and Engage in Science Practices

S8.14.1 Investigating Student Engagement, Thinking, and Learning in Science – Findings from a Year-long, Inquiry-Based Teaching Experience

Sybil S. Kelley, Portland State University
Dalton Miller-Jones, Portland State University
William G. Becker, Portland State University

This paper presents the outcomes of a study that took place as part of a school-university partnership during the 2006-07 school year. The study employed an ethnographic approach to building a substantive grounded theory, investigating how students become engaged in and learn science. Findings from this investigation were derived from student-level data, and were nested within the larger context of the school and district. This broader context provided an avenue to interpret the student-level data in relation to the larger systems that sometimes support and sometimes hinder progress towards building scientific literacy among adolescent learners. The emerging grounded theory addressed how despite very intentional efforts of teachers and researchers to use culturally congruent teaching practices, there was still tension between the mainstream culture of school and the cultures – norms, language and actions – that students brought to the classroom. This reality points to some of the challenges in implementing culturally congruent teaching practices in an urban middle school, and provides insights to help address them. From the understandings gained through the analysis of individual student-level data, we will share lessons-learned and recommendations that pertain to classroom, school and system-level operations.

S8.14.2 The Influence of Gender, Context, and Racial Self-Concept on African American Early Adolescents' Motivation to Engage in Science Literacy Practices

Tanya Cleveland Solomon, University of Michigan

Literacy practices are social practices around reading and writing of texts shaped by people's ideologies. In schools, literacy practices demonstrate certain skilled abilities depending on the domain. In science classrooms, literacy practices take specific forms such as facility with reading and writing expository texts. This paper uses survey data to examine how gender, race, and contextual factors are associated with African American seventh graders' (N=135) self-perceptions and values related to literacy practices such as reading textbooks and learning vocabulary. Regression models are presented that explain the main and interaction effects of these risk factors on students' perceptions of competence in and values for literacy practices in science. Implications of these results for African American early adolescents' engagement in science classrooms will then be explored.

S8.14.3 Cultural Aspects of Argumentation and the Implications for Engaging Youth with What it Means to Argue Scientifically

Leah A. Bricker, Loyola University Chicago

Argumentation is a core epistemic practice in the sciences and because of this, calls for engaging youth in science classrooms with what

it means to argue scientifically are becoming more commonplace. There have been several curricular and instructional efforts aimed at giving youth the opportunity to learn how to argue scientifically but those orchestrating the efforts all report that youth have a difficult time participating in such tasks as coordinating theory with evidence. Even though argumentation is a well-established part of peer culture, none of these projects have taken account of youth argumentation as it is locally-situated and embedded within and employed across activity systems for particular purposes. This paper reports on findings of youth argumentative practices across settings and embedded in valued activity systems. Data stem from a longitudinal team ethnographic study of youth science and technology learning across settings and timescales. Specific cultural aspects framing youth argumentative practices are explicated and discussed in light of their implications for engaging youth with what it means to argue scientifically.

S8.14.4 From a "Hybrid Discourse" towards "Legitimate Peripheral Participation"

Hayat F. Hokayem, Michigan State University
Angela Calabrese Barton, Michigan State University

Subscribing to a socio-cultural perspective of learning, we believe that learning is situated and inherently linked to the "cultural resources" and practices in a certain environment. We use the concept of "legitimate peripheral participation as a theoretical lens to investigate learning in a club of small urban Midwestern City. Fifteen club member (11 to 12 years of age) participated in GET (Green Energy and Technology) City program that capitalized on participants concrete experience in addition to technological and human resources to discuss food and carbon footprint of club's lunch and canteen. We adopted an ethnographic research method in order to code and analyze video tapes, interviews and movie products at the end of the five weeks. Our finding lead us into two main claims with how and why hybrid spaces seemed to matter: First, the youth sought to create and enact a hybridized discourse that called attention to and elevated the value of their scientific findings. Second, the youth drew on aspects as hybridization as central to their role as legitimate participants in their GET City community. In other words, hybridity became a defining and necessary feature for valued participation as defined and enacted by the youth.

S8.15 Strand 12—SC-Paper Set: How do Computer Simulations Enhance Teaching and Learning?

S8.15.1 The Use of a Computer Simulation to Promote Conceptual Change: A Quasi-Experimental Study

Randy L. Bell, University of Virginia
Kathy Cabe Trundle, The Ohio State University

This mixed-methods investigation compared the effectiveness of three instructional approaches in achieving desired conceptual change among preservice early childhood teachers (n = 157). Two of the three instructional interventions integrated planetarium software (Starry Night) with inquiry-based instruction on moon phases. The three treatments included instruction in which participants 1) used a computer simulation exclusively for data gathering; 2) collected observations from both the computer simulation and from nature; and 3) collected data solely from nature. Data sources included drawings, intensive interviews, and a lunar shapes card sort. The data sets were analyzed via a constant comparative method in order to produce profiles of each participant's pre- and post- instruction conceptual understandings of moon phases. Quantitative analysis consisted of a two way, one between and one within group repeated measures analysis of variance. Pre- to post-instruction gains were substantial and significant for all three treatments across all targeted concepts. However, participants using Starry Night exclusively made significantly greater gains than those who gathered observations from Starry Night with nature or from nature alone. Results demonstrate that a well-designed computer simulation can be effective in eliciting desired conceptual change.

S8.15.2 Incorporation of Computer Simulations in Whole-class Vs. Small-group Settings

Lara K. Smetana, Southern Connecticut State University
Randy L. Bell, University of Virginia

This study explored the use of computer simulations in a whole-class as compared to small-group setting. Specific consideration was give to the nature and impact of classroom conversations and interactions. The study involved a chemistry teacher and two of her honors classes. Data collection allowed for triangulation of evidence from a variety of sources: 24 hours of video- and audio-taped classroom observations, field notes and an analytic journal; miscellaneous classroom artifacts; open-ended pre- and post-assessments; student and teacher interviews. Classroom observations, artifacts and interviews were analyzed using analytic induction. Assessments were analyzed using ANCOVA. Findings indicated (a) students in both groups significantly improved their understanding of the chemistry concepts (c) there was no statistically significant difference between groups' achievement (d) there was more frequent highly collaborative talk in the whole-class group (e) there were more frequent and meaningful teacher-student interactions in the whole-class group (f) the potential benefits of highly collaborative talk in the whole-class setting were not fully realized. These findings suggest that both whole-class and small-group settings are appropriate for using computer simulations in science. The effective incorporation of simulations into whole-class instruction may provide a solution to the dilemma of technology penetration versus integration in today's classrooms.

S8.15.3 What You See Is Not Always What You Get: Using Digital Video Technology to Research the Preservice Preparation of Elementary Science Teachers

Paul Bueno de Mesquita, University of Rhode Island
Ross F. Dean, University of Rhode Island
Betty J. Young, University of Rhode Island

The purpose of this paper is to identify and discuss the opportunities and challenges of incorporating digital video technology into the study of preservice science teacher education. Advances in digital video technology offer significantly enhanced methodologies for studying the development of science teaching efficacy along the teacher professional continuum from preservice methods, through student teaching, and into induction years. User-friendly digital cameras and highly compatible software programs have made the tasks of video capture, editing, transcription, and subsequent data analysis more convenient, accurate, and reliable than ever before. Although such technological developments offer a myriad of opportunities for advancements in research and training, especially in the area of preservice science teacher education, a number of technical challenges and unforeseen difficulties may arise when relying on video-based methodologies. Video examples and lessons learned will be shared from an on-going NSF-funded study concerning the development of preservice elementary teachers using an inquiry-based model of science instruction, in which a state of the art video editing software package is used to capture, code, label, and analyze teacher behaviors and verbalizations. Relevant research is reviewed and implications for preservice teacher education will be discussed.

S8.15.4 Instructional Support for Learning with Computer Simulations about the "Ecosystem Water"

Marc Eckhardt, University of Kiel
Detlef Urhahne, University of Munich
Olaf Conrad, University of Hamburg
Ute Harms, University of Kiel

Computer simulations provide learners with the opportunity to carry out experiments that are otherwise too difficult to conduct in school. However, for successful knowledge acquisition with computer simulations instructional support is needed, as learning with computer simulations does not typically result in the desired learning outcomes. The main objective of our project is to answer the question which kinds of instructional support may improve knowledge acquisition, particularly learning principles in biology, when working with computer simulations. In two well known problematic domains of inquiry learning – data interpretation and self- regulation – instructional support for learning with computer simulations are developed and tested. In a first study a computer simulation and particular instructional measures concerning data interpretation and self- regulation were developed and tested with students. The effectiveness of the revised instructional measures on students´ learning outcome, the ability to work in a learning environment that offers a high degree for self- regulation and the ability to interpret experimental data is investigated in a second study. The data are raised in an experimental setting using a 3x2-factorial design with pre- and post-tests. Posttests yielded a significant knowledge gain whereas certainly combined instructional measures seem to hinder conceptual and intuitive knowledge acquisition.

S8.16 Strand 13—SC-Paper Set: Representations of Science in Practice, Writing, and Textbooks

S8.16.1 Understanding Differences in Scientific Methodology via Language Analysis

Jeff Dodick, The Hebrew University of Jerusalem, Israel
Shlomo Argamon, Illinois Institute of Technology
Paul Chase, Illinois Institute of Technology

A focus of the current education reforms involves developing inquiry-based learning materials. However, without an understanding of how scientists actually do science, such learning materials cannot be developed. Until now, research on scientific reasoning has focused on cognitive or ethnographic studies of individual sciences. However, the question remains as to whether scientists in different fields fundamentally rely on different methodologies. Although many philosophers of science agree that there is no single scientific method, this has never been tested empirically. We therefore approach this problem by analyzing patterns of language used in scientific publications. Our results demonstrate systematic variation in language use between types of science that are thought to differ in their characteristic methodologies. The features of language use that were found correspond closely to a proposed distinction between Experimental Sciences (e.g., chemistry) and Historical Sciences (e.g., geology); thus, different underlying conceptual mechanisms likely operate for scientific reasoning and communication in different contexts. Such comparative studies are crucial for educating teachers, and students that there are different methodologies in science. Moreover, such studies provide educators with the tools to broaden the science curriculum so as to expand students' understanding of different modes of scientific reasoning, while enhancing their scientific literacy.

S8.16.2 A Longitudinal Analysis of the Representations of Nature of Science in High School Biology and Physics Textbooks

Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign
Nader Wahbeh, University of Illinois at Urbana-Champaign
Noemi Waight, State University of New York at Buffalo
Ava Zeineddin, Wayne State University

This study assessed ways in which several key aspects of nature of science (NOS) are represented in high school biology and physics textbooks and the extent to which these representations have changed over the course of several decades. The sample included 39 textbooks (21 biology and 18 physics) in seven "connected series" with significant market shares. Textbooks were scored to reflect the accuracy, completeness, and manner in which the target NOS aspects were represented. The textbooks fared poorly in their representations of NOS, and scores for all series either did not change or decreased over the past several decades pointing to a trend that is incommensurate with the discourse and efforts of national reform efforts in science education.

S8.16.3 The Empirical Attitude, Material Practice, and Design Activities

Xornam Apedoe, University of San Francisco
Michael Ford, University of Pittsburgh

This article represents a case for sustained attention in science curricula on what we characterize as the empirical attitude. The empirical attitude is key to the success of modern science and fundamental to understanding how it works. It is comprised by an acknowledgement that our ideas about nature may be wrong and an active search for feedback from the material world that can help us make these ideas better. We draw on recent work in philosophy of science to highlight how scientific reasoning includes two mutually supportive processes of (1) positing phenomena (regularities in nature's behavior that can be identified and characterized through empirical work) and (2) designing material arrangements that could frame and measure these phenomena. As such, we propose a view of scientific practice as involving both conceptual and material aspects, highlighting how the material aspect manifests the empirical attitude and is fundamentally related to design. We argue therefore that design is severely overlooked in science curricula, concerning its role in science and its utility for supporting development of the empirical attitude instructionally. We share analyses of student performances on a design task to elaborate and support these claims.

S8.16.4 Junior Chemists' Understanding of the Nature of Scientific Theories and Laws

Frackson Mumba, Southern Illinois University
Jeffrey Carver, West Virginia University
Vivien Chabalengula, Southern Illinois University
William J.F. Hunter, Illinois State University

The purpose of this study was to assess five junior chemists' understanding of the characteristics of scientific theories and laws, their functions and relationships before and after an intervention. The junior chemists were serving in a University-School partnership project funded by a government agency. The junior chemists were training to be scientists and not high school teachers. Data were collected through pre and post-test questionnaires and semi-structured interviews. Data were analyzed by coding the responses to identify recurring themes. Then, the categories were generated and provided representative profiles of the group studied. Results show that before instruction most junior held un informed views on the characteristics of scientific theories and laws, their functions and relationships. However, after instruction most junior chemists developed better understanding of these concepts. Four types of relationships between scientific laws and theories emerged from participants' responses: discrete, intertwined, concentric, and cyclical. The findings have considerable implications for teacher education, science teaching and learning and training of graduate teaching assistants at university level.

S8.17 Strand 15—Strand Invited Symposium: Quality Research, Policy, and Practice in Service of Science Education: Part 1—Principles and Procedures

Stephen P. Norris, University of Alberta, Canada
Linda M. Phillips, University of Alberta, Canada
Richard K. Coll, University of Waikato, New Zealand
Hsiao-Ching She, National Chiao Tung University, Taiwan
Mack C. Shelley II, Iowa State University
Larry D. Yore, University of Victoria, Canada
Brian Hand, University of Iowa

Influencing classroom practice and public policy is complex and varies across jurisdictions. The current mode of academic research in which researchers do inquiry and publish results with the belief that teachers and politicians will pick up these results and use them to inform instruction and influence policy does not work. Some in the science education community would say there needs to be a change in the research approach to focus on the complex, dynamic, interactive processes of learning and teaching in specific sociocultural contexts, while others would suggest that science education researchers need to become more aware of the need for and active in the process of public policy. The six issues addressed in Part 1 highlight insights into the basic processes and principles used to inform, influence, and persuade public policy as NARST develops policy strategies for science education (see program abstract). The following brief presentations (6-8 minutes) will explore fundamental issues related to informing and influencing public policy and procedures by using evidence-based knowledge and academic expertise for informing, crafting, and promoting policy regarding science education.

S9.1 Research Committee Sponsored Session—Symposium: Scale-Up Research in Science Education: A Grand Challenge for Science Education or Grand Delusion?

Sharon J. Lynch, George Washington University
Nancy Butler Songer, University of Michigan
Michael R. Vitale, East Carolina University
Nancy R. Romance, Florida Atlantic University
Bill Watson, George Washington University
Curtis Pyke, George Washington University

This symposium will discuss 3 science education interventions and their scale-up in school districts, drawing on theory to explain their scale-up trajectories. Songer uses the Bio-KIDS project and incorporates learning progressions into scale-up theory, discussing results for a large urban school district. Vitale and Romance report findings emerging from a multi-year project to study a multi-phase scale-up model for Science IDEAS in grades 3-5. Lynch, Watson & Pyke present data that indicates that small scale effects for curriculum materials may not be sustained at large scale, due to a changing policy climate over the course of their study. Presenters from the 3 studies will respond to questions that affect grand challenges of science education research: 1. What evidence is there that your intervention is effective and what were the study's methodological challenges? 2. What problems were encountered in working with partner school districts that limited or threatened the design of your study? Were there unanticipated affordances provided that enhanced your study design? 3. Did the intervention scale-up and was it sustained? Why or why not? 4. How generalizable is your research? 5. What have you learned about science education research and the scale-up of science education interventions?

S9.2 Research Committee Sponsored Session—Technology Symposium: Higher Education Opportunities with Apple Computer Inc.

Rae Niles, Apple Computer Inc.

Apple Computer Inc. has provided this technology venue for NARST so that researchers, reformers, and innovators in science education can showcase their work in ways that transcend traditional conference delivery methods. In this brief session Apple will meet and greet Higher Education faculty and discuss their latest initiatives in Higher Education including iTunes-U, and other digital media initiatives. Apple Professional Development works with higher education faculty to engage students with a 21st century digital learning environment that mirrors the way they live – and learn. The digital skills developed in Apple Professional Development workshops enhance your faculty's courses and enable them to connect more deeply with today's students. This session provides among other things an overview of Apple Professional Development offerings for higher education, as well as the opportunity for conversation around how today's student learn. Attendees to this session will understand how Apple Professional Development has impacted other colleges and universities and how it can enhance what you do in your classes to reach your students!

S9.3 Strand 1—SC-Paper Set: Representing Matter II

S9.3.1 The Impact of Curriculum on Conceptual Understanding and Theoretical Framework

Sharon P. Schleigh, East Carolina University

This study explores the impact of curriculum on the amount of gains students have in conceptual understanding for the force concept and in their conceptual theoretical structures. Participants included 25 students from a 10th grade introductory high school physics class. The curriculum included the use of Arizona State University's Modeling Program in Newtonian Mechanics. Students were interviewed and their ideas were coded to determine the level of consistency in their theories as well as the category of force meanings. Students also participated in a pencil and paper assessment called a Force Concepts Inventory which provided information regarding the students' conceptual understanding. A statistical analysis of the change in conceptual understanding, conceptual theoretical framework and the interaction between these two areas' of student learning/thinking was conducted. A discussion includes the role of curriculum and instruction in how students that and in what they think.

S9.3.2 Using a Nanoscience Context to Develop and Evaluate Student Conceptions of the Relationships among Observations of Materials and their Particulate Explanations

Clara S. Cahill, University of Michigan
Joseph Krajcik, University of Michigan

The particulate nature of matter is a consistently difficult conception for students. The nanoscience-based concept of surface-dependent properties provides a context through which to closely link observable behaviors and characteristics of materials to underlying causal mechanisms, including differences in the number and arrangement of particles. Thus, surface-dependent properties provides a new potential method to help students understand the particle model of matter. This study evaluates the conceptual understanding of 32 diverse middle-school students participating in an intensive instructional intervention utilizing the aforementioned principles. Student understanding of the relationships amongst the observable properties of materials and the connections between these macroscopic-level understandings, nanoscale models and explanations, and the particulate nature of matter are explored. Learning pathways for each student were created from written artifacts. Students who developed a particle model consistent with the behavior of nanoscale materials were slightly more likely to use their particle model to explain differences in mass and rate of concentration change than students whose particle model was consistent with the behavior of bulk materials.

S9.3.3 Patterns of Progression in Students' Understanding of Combustion

Chih-Che Tai, Columbia University
Keith Sheppard, Stony Brook University

This study used a cross-age design to investigate the progression in students' learning about the topic of combustion. The study used six knowledge and twelve cognitive ability questions to investigate 1,237 students' understanding of combustion. The population included students from grades 6 through 12 and also 76 university students. Six patterns were found to describe how students developed their understanding of combustion, including (I) gradual increase, (II) stepwise increase, (III) persistent misunderstanding, (IV) early understanding, (V) varied understanding and (VI) reverse-V understanding. The first two age-related patterns are consistent with what the previous studies claimed about the importance of age maturation and the length of formal school science learning in promoting students' understanding. However, the next four non-age-related patterns suggest that age maturation is not necessarily a determining factor in developing understanding and that current curriculum and instruction in school are not effective in promoting students' understanding of some science concepts. The study brings several implications for science teachers and science teacher educators. For example, teachers can utilize the findings to modify current ineffective instruction and develop different instructional strategies to overcome students' alternative conceptions.

S9.3.4 Physics Students' Mental Models of Thermal Conduction: Their Emerging Cognitive Representations of the Dynamic Processes and Their Resulting Predictions

Guo-Li Chiou, Columbia University
O. Roger Anderson, Columbia University

The goal of this study was to explore thirty college-level physics students' mental models of thermal conduction by eliciting their interview-based explanations of the dynamical processes of thermal conduction, and by examining the relationship between the emerging mental representations and the students' predictions about how thermal conduction proceeds in different materials. Semi-structured interviews were conducted to elicit the students' various representations of thermal conduction, and a constant comparative method was adopted to analyze theses representations to establish patterns of their explanations for thermal conduction and their consequent predictions. Results indicate that the characteristic features and numbers of the different patterns of the dynamical processes of thermal conduction may represent different developmental states of mental models as suggested by Vosniadou and Brewer (1994). Also, not all students consistently applied the same mental model when presented with different instances of heat conduction, and the consistency of mental models appears to depend on the level of the students' expertise and the salient property of the materials in which conduction occurs. Moreover, the students' predictions for given systems seemed to be directly retrieved from their learned scientific principles or intuitive beliefs, and had no significant relationship with their dynamical processing models of thermal conduction.

S9.4 Strand 1—Symposium: Coherence and Science Content Storylines in Science Teaching: Evidence of Neglect? Evidence of Effect?

Kathleen J. Roth, LessonLab Research Institute
Meike Lemmens, LessonLab Research Institute
Helen E. Garnier, LessonLab Research Institute
Catherine Chen, LessonLab Research Institute
Nicole I. Z. Wickler, California State Polytechnic University, Pomona
Jo Ellen Roseman, AAAS Project 2061
Angela Calabrese Barton, Michigan State University
Carla Zembal-Saul, Pennsylvania State University
Leslie J. Atkins, California State University, Chico
Andrew W. Shouse, University of Washington

This session re-examines the development of canonical science content ideas in science teaching by stimulating a discussion about these focus questions: What evidence is there that coherent science content development in science teaching is important for student learning? Has the reform-based focus on science inquiry teaching led (unintentionally or not) to a diminished focus on the development of canonical science content ideas? If so, is this a problem? The session opens with a brief presentation of results from two recent studies that suggest the importance of coherent science content storylines in science teaching. A panel of researchers representing different perspectives will then draw from their own work to comment on the session focus questions. After all the panelists have made their opening comments, there will be cross-talk among the panelists followed by comments from a discussant and questions/comments from the audience.

S9.5 Strand 2—SC-Paper Set: Epistemological Beliefs and Perceptions in Learning Scientific Phenomena

S9.5.1 Students' and Teachers' Conceptions of Surface Area to Volume in Science Contexts: What Factors Influence the Understanding of the Concept of Scale?

Amy R. Taylor, University of North Carolina Wilmington
M. Gail Jones, North Carolina State University

This study explored the relationships among proportional reasoning skills and visual-spatial abilities with the understanding of the scale concept of surface area to volume. The National Science Education Standards stress teaching unifying concepts and processes that promote connections between and among traditional scientific disciplines (NSES, 1996). Proportional reasoning ability and visual-spatial skills all contribute to learning science but the relationships among these factors with how someone understands surface area to volume has not been fully explored. Correlation and multiple linear regression analyses determined that there is a relationship between one's ability to understand surface area to volume relationships and proportional reasoning, cognitive developmental level, and visual spatial ability. Regression results indicated that all participants' proportional reasoning and visual- spatial scores could be a possible predictor for one's ability to understand surface area to volume relationships. Discussion of the results is followed by implications for teaching scale concepts such as surface area to volume in the science classroom.

S9.5.2 Personal Epistemological Belief Changes in a Chemistry Laboratory Environment

Linda Keen-Rocha, University of South Florida
Dana Zeidler, University of South Florida

The nature of this study was to explore changes in beliefs and lay a foundation for focusing on more specific features of reasoning related to personal epistemology in light of specific science laboratory instructional pedagogical practices (e.g., pre- and post- laboratory activities, laboratory work) for future research. This research employed a mixed methodology, with a population of 56 students enrolled in several chemistry laboratory courses, with the qualitative analysis focusing on the in-depth interviews. A quantitative epistemological beliefs (EBAPS) measure was administered pre- and post-instruction. These measures were triangulated to assure the rigor of the descriptions generated. The EBAPS results: the mean gain scores for the overall score and all dimensions, except for the source of ability to learn were found to be significant at $p \leq .05$. The participants' identified the laboratory work as the most effective instructional feature followed by the post- laboratory activities. The participants suggested the laboratory work offered real-life experiences, group discussions, and teamwork which added understanding and meaning to their learning. What one cannot infer at this point is whether these belief changes and beliefs about laboratory instruction are enduring or whether some participants are simply more adaptable than others are to the learning environment.

S9.5.3 Quantifying High School Students' Self-Perceptions in Learning Chemistry

Murat Kahveci, Canakkale Onsekiz Mart University, Turkey

The purpose of this study was two-fold: (1) to investigate high school students' self- perceptions in learning chemistry by a comparative analysis with respect to varying personal characteristics such as gender, grade level, and major (i.e., Science and Mathematics, Social Science-Mathematics, and Undecied) in learning chemistry, and (2) to provide evidence for the reliability of the modified Fennema-Sherman attitude survey to measure students' attitudes towards learning chemistry. A modified version of Fennema-Sharman attitude scale was administered to Language Prep, 9th, 10th, and 11th grade students. Reliability of the instrument, factor analysis, and GLM analysis of the results were provided in detail. The internal consistency analysis revealed that the instrument had Cronbach alpha values ranging from .90 to .73, referred as highly reliable. The factor analysis showed that there were seven different thematic categories among the items. Overall, findings indicated that students had positive attitudes towards learning chemistry, regardless of their various personal characteristics such as gender, grade level, and major. In addition, students at higher grades tended to have more satisfaction in learning chemistry compared to lower grades. Although male and female students were moderately confident in learning chemistry, female students rated statistically siginificantly higher than male students in their confidence ratings.

S9.5.4 Response Characteristics of Middle School Learners' Critiques of Nanoscale Phenomena Representations

Tom Moher, University of Illinois
Brenda López Silva, University of Illinois at Chicago
Shanna Daly, Purdue University
Marco Bernasconi, University of Illinois

Middle school students were asked to critique three representations of DNA nucleotide strands—a paper-and- pencil static representation, a tangible representation using "pop beads" to represent nucleotides, and a computer simulation—that they used in design tasks within an instructional unit on nanoscale self-assembly. Student responses were coded into six response categories. Responses generally focused on visual and interactive affordances of representations rather than issues of enjoyment or task difficulty. Positive responses outnumbered criticisms, with visual affordances dominating negative responses. Distribution among response categories varied little across representational forms, but the simulation elicited the strongest positive response, with the paper-and-pencil representation drawing the strongest criticisms. This study provides tentative support for the explicit introduction of representational critique generally, and further, for the use of multiple representations as stimuli for such activities, especially when the phenomenon are from domains in which the learners lack direct experience or prior understandings.

S9.6 Strand 2—Related Paper Set: Affective Learning Environments: Opportunities for Complexity Thinking in Science Education

S9.6.1 Complexity Thinking in Science Education: A Theoretical Framework and Applications

Rachel F. Moll, University of British Columbia
Jeff J. Baker, University of British Columbia

Complexity science, thinking or sensibilities are relatively new and have yet to be taken up widely within educational discourses. However, readings of complexity are often centered around learning. Complex systems are learning systems and an important characteristic of complex systems is emergence or self organization. Complex systems are autopoetic; creating unities or simplicities by using the simple rules of a distributed network of connections and experiences, in the absence of a central controller. By employing a complexity thinking framework to research in science education several perspectives on learning emerge. This introductory paper for the related paper set entitled: Affective learning environments: Opportunities for complexity thinking in science education, provides some background on complexity thinking as a theoretical framework and uses three examples to exhibit the contribution this perspective can bring to science education. The examples explore a) deeper understandings about the role of affective learning in science, b) structuring learning experiences in science outreach contexts, and c) possibilities for sustainability education. Recommendations for structuring meaningful learning experiences in both informal science outreach activities and within a sustainability education curriculum emerged from employing this perspective, alongside an increasing awareness of the importance of the affective domain of learning.

S9.6.2 Emergence of Metacognitive Awareness in a Complex Learning System

Wendy Nielsen, University of British Columbia

Metacognitive awareness and control are two key dimensions of individual learning behavior. Awareness can be considered an entry-level behavior for engaging with the learning situation, and when learners function in groups to work on classroom activities or projects, individual behaviors contribute to the group effort. The learning context for this paper involves high school biology students visiting a city Aquarium for curriculum-based experiences that are linked to follow-up activities back in the classroom. The study engaged students in novel problems with the express intention of activating metacognitive behavior, and uses an activity theory framework to observe and analyze group interactions in the context of these activities. The goal for this paper is to describe the manifestation of the metacognitive dimensions of awareness and control in the context of group problem-solving activity.

S9.6.3 A Complex View of Science Learning

Anne Fiona White, York University
Sheliza Ibrahim, York University
Steve Alsop, York University

This paper reports on a case study in which student views of science and their learning of science emerged through their participation in a project involving photojournalism of science in their community. As part of a larger participatory action research project involving affect in science education, the study documents the involvement of four middle school classes using a place-based and visual approach to science learning, with teachers deliberately creating activities that allowed for possibilities for science learning that were open-ended, unpredictable, and collaborative. Features of complex systems are explored during the analysis of the data, which includes the student-generated images, providing evidence of students developing a broader view of how science is connected to their lives. Themes evident in the images include science as nature, science as process, and science as technology.

S9.6.4 A Field Zine to Science and the City: Remembering Community Interactions and Place-Based Projects

Sheliza Ibrahim, York University
Melissa Blimkie, York University
Anne Fiona White, York University
Steve Alsop, York University

The proposed paper reports the importance of remembering and celebrating science agency among students. The remembering process serves as a complex system where re-learning, re-visiting and re-engaging with science offers a recursive experience. During a two year pedagogical intervention, Grade 6-8 students completed science action research projects that explored science as it intersected in their daily lives and communities. To remember and celebrate their science activism, a year after completing place-based science projects, students and teachers participated in the creation of a zine, which was disseminated throughout their community. Our paper makes a significant contribution to place-based science pedagogy, which is often critiqued for engaging students in a one time only school- community project, by demonstrating the importance of reflecting on the impact of critical place-based projects a year later and by discussing the transitory and dynamic nature of science education.

S9.7 Strand 4—SC-Paper Set: Secondary Science Teachers' Perspectives about Learning and Instruction

S9.7.1 The Influence of Teacher Education on Prospective Science Teachers' Rationales for Instructional Activity Selections

Debra Tomanek, University of Arizona
Ingrid Novodvorsky, University of Arizona
Vicente Talanquer, University of Arizona

The purpose of this qualitative study was to identify factors that influence prospective secondary level science teachers' preferences for different types of instructional activities. The major factors were generally associated with a science activity's potential to: (1) develop skills that transfer to other life tasks, and (2) establish relevance and motivation for student engagement with the curriculum. To a lesser extent, prospective teachers used factors related to an activity's potential to: (3) promote learning, and (4) serve as a tool for assessment. Our teacher preparation program had little impact on the prospective teachers' use of transfer and relevance. Small differences were found between novice and more experienced prospective teachers' use of factors associated with motivation, learning, and assessment. Some beliefs that support instructional decisions may be so robust that teacher preparation can do little to alter them (e.g., science process skills are useful in life problem- solving). However, other beliefs, such as those related to learning and assessment, may be less strongly held by prospective teachers and more easily altered through teacher education.

S9.7.2 Teacher Noticing In-the-Moment of Instruction: The Case of One High-School Science Teacher

Melissa J Luna, Northwestern University
Rosemary S. Russ, Northwestern University
Adam Colestock, Northwestern University

Enacting science education reforms that call for the teaching of science as argument and explanation (NRC, 1996) requires that teachers both recognize student thinking as it happens and make in-the-moment instructional responses to what they notice. Much work in teacher education is thus devoted to studying, supporting, and improving teacher noticing (e.g. Sherin, 2001). However, although there is agreement that we want teachers to notice their students' thinking, we still know very little about what science teachers actually attend to in the moment of instruction. In this work we report on the use of a new video technology, the Camwear 100 (Reich, Goldberg, & Hudek, 2004), that allows us to capture in real time what one high school environmental science teacher notices in his classroom during teaching. In addition, interviews with the teacher give us insight into why he notices the things that he does. This preliminary trial reveals his interest in the quality and level of his students' engagement, and his attention to his own questions to his students. We discuss the implications of this trial for future work on teacher noticing.

S9.7.3 One-On-One Science Instruction

Rhea L. Miles, East Carolina University

A majority of in-service and pre-service teachers reported they would provide science tutorial instruction for a student after school. Most teachers did indicate they would sometimes rely on technology, peer tutoring and themselves for one-on-one science instruction. However, many teachers marked on the survey they would never rely on outside assistance such as family or science enrichment programs. When asked, "How do you describe a typical one-on-one science tutorial session?" both in-service and pre-service teachers categorized the sessions as teacher-directed. Ultimately, a significantly large percentage of pre-service teachers were more likely to utilize student-directed or student- teacher partnerships strategies for science tutorial instruction than the in-service teachers. Finally, the African-American and Hispanic student population have the largest proportion of students in need of one-on-one science instruction.

S9.8 Strand 5—SC-Paper Set: Biology and Chemistry: Instruction and Assessment

S9.8.1 Model-Based Inquiry as a Context for Supporting Undergraduates' Epistemic Resources

Julia Svoboda, University of California, Davis
Cynthia Passmore, University of California, Davis

A commonly held assumption is that through participation in inquiry-based science learning students will acquire sophisticated scientific epistemologies. However, studies have shown that undergraduates' epistemologies remain far removed from the sophisticated ideal. Scholars such as Hammer and Elby have suggested that students activate different "epistemic resources" depending on the context. In

this research we identified the epistemic resources students activated in the context of model-based problem solving. Because models function as the key epistemic tools in scientific research, we hypothesized that model-based inquiry might be an ideal context in which to study students' use of epistemic resources. We report on nine undergraduate students' participating in a yearlong fellowship in quantitative biological modeling. Our qualitative analysis of students' practices in addition to their self-reports allowed us to both identify instances of epistemological thinking and connect these instances to particular features of the model-based inquiry context. We found that problem solving activities such as model articulation and evaluation successfully activated epistemic resources in a broad range of sophistication. This research suggests that model-based inquiry environments are rich contexts for epistemological thought and implies that the affordances of model-based activities can be important for informing science curriculum design.

S9.8.2 Student Learning with the Case Study Method of Instruction

Kathy K. Gallucci, Elon University

The purpose of this study was to investigate the effect of the case study method of instruction (CMI) on conceptual change in students' understanding of biological concepts, and to investigate the effect of learning with CMI on student attitude regarding the discipline of science, and learning about science. Twelve student volunteers were interviewed twice, once after each exam, by an independent interviewer, to elicit their understanding about the method, their understanding of the concepts, and their attitudes about learning science. The interviews were audio taped and transcribed, and analyzed for themes and comments about conceptual understanding and learning about science. According to the interview data, CMI presented a new learning paradigm for students and many agreed that the method made learning more interesting, motivating, and relevant, and as a consequence they learned more science and expect to retain knowledge longer. CMI is a teaching strategy that can promote student engagement in learning science and may help students to make progress toward conceptual change.

S9.8.3 Cognitive Task Analysis as a Basis for Instruction in Experimental Design and Analysis: Impacts on Skill Development and Student Retention in the Biological Sciences

David F. Feldon, Washington State University
Kirk A. Stowe, University of South Carolina
Richard Showman, University of South Carolina

Nationally, undergraduate majors in the biological sciences have high rates of attrition. The average dropout rate is around 50% (Seymour, 2001). In a national study of college freshmen who initially declared STEM majors, 90% of students who switched to non-science majors cited ineffective instruction as a primary reason. Of those who successfully completed degrees in STEM programs, 74% indicated that poor instruction was a major problem (Seymour & Hewitt, 1997). Using a double-blind design, this study tested the hypothesis that the lack of explicit procedural instruction in scientific problem solving is a major factor in low STEM retention and underachievement (n=316 undergraduates enrolled in an introductory cellular, genetic, and molecular biology lab course). Cognitive task analysis was used to elicit experts' procedural knowledge of how to effectively design experiments and analyze results. The instruction was delivered using streaming video. Students in the treatment condition acquired relevant skills significantly more effectively performed better on course assessments, and were significantly more likely to complete the course than students in the comparison group.

S9.8.4 Using Lexical Analysis Software to Understand Student Knowledge Transfer between Chemistry and Biology

Kevin C. Haudek, Michigan State University
Rosa A. Moscarella, Michigan State University
Mark Urban-Lurain, Michigan State University
John Merrill, Michigan State University
Ryan D. Sweeder, Michigan State University
Gail Richmond, Michigan State University

Time and resources often prevent using constructed response assessments in large undergraduate science courses. We investigate the utility of using lexical analysis software to categorize student responses and uncover undergraduate student misconceptions in chemistry and biology. Students were randomly assigned a question set consisting of two questions relating to free energy or acid/base chemistry. Student responses were analyzed using SPSS Text Analysis for Surveys, using a custom library of science-related terms. The resulting analyses of student responses suggest potential barriers and connections between students understanding of these topics. Only 38 out of 160 students linked reaction spontaneity with thermodynamics. Student responses for the acid/base question set were rated using a scoring rubric by two independent scorers. Analysis of this question set showed student deficiencies in predicting pH behavior of functional groups in biology. After this scoring was complete, discriminant analysis was used to create classification functions that could predict human expert scores with 65.4% and 82.4% accuracy ($p < .000$). This study suggests that computerized lexical analysis may be useful for automatically categorizing large numbers of student open-ended responses.

S9.9 Strand 7—SC-Paper Set: Preservice Teachers' Perceptions of the Nature of Science

S9.9.1 Preservice Science Teachers' Informal Reasoning Regarding Socioscientific Issues and the Factors Influencing Their Informal Reasoning

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Ozgul Yilmaz-Tuzun, Middle East technical University
Troy D. Sadler, University of Florida

The aim of this study was to explore Preservice Science Teachers' (PSTs) informal reasoning and the factors influencing their informal reasoning. Constant comparative method (Glaser & Strauss, 1967) and seven socioscientific issues (SSI) were used to explore informal reasoning and influencing factors. Three SSI dealt with gene therapy and the other three issues dealt with cloning. The last issue dealt with global warming. Two interview protocols were used in the present study. Informal Reasoning Interview protocol focused on the exploration of informal reasoning, and Moral Decision-Making Interview protocol was used to explore the factors influencing informal reasoning. Totally, 39 PSTs voluntarily participated in the study. Senior elementary PSTs from a large public university, in city, a country were the intended sample for this study. Emergent informal reasoning categories from the present study were: rationalistic, emotive, and intuitive informal reasoning patterns. In addition, main factors influencing participants' informal reasoning were accumulated under four main categories; personal experiences, social considerations, moral-ethical considerations, and technological concerns. Furthermore, the social considerations category consists of three sub-categories; economic, educational, and religious considerations.

S9.9.2 Examining the Efficacy of an Explicit and Reflective Course on the Development of Preservice Secondary Science Teachers' Conceptions of Nature of Science

Ron E. Gray, Oregon State University
Nam-Hwa Kang, Oregon State University

The purpose of this study was to understand the development of preservice secondary science teachers' conceptions of nature of science (NOS) over a reflective and explicit course intervention and throughout a teacher education program. Fourteen preservice secondary science teachers participated. Through open-response surveys and interviews, we examined participants' conceptions regarding eight aspects of NOS. Initial conceptions were shown to be less sophisticated for most aspects of NOS, but sophisticated for the social aspect of science as well as the relationship between science and technology. Conversely, conceptions of the diversity of methodologies employed by scientists were naive as most participants described a "universal scientific method." After the course intervention, participants refined their conceptions; most notably, their conceptions of the diversity of scientific methodologies and the certainty of scientific knowledge. Participants utilized their learning from activities in the course indicating the effectiveness of activities for their learning. After the course intervention, participants' conceptions remained relatively stable over the 8-month period of the study. Those aspects that remained most stable or showed further positive development were implicit in further coursework of the teacher preparation program. The findings provided curricular and instructional implications.

S9.9.3 Developing Pedagogical Content Knowledge for Teaching the Nature of Science: Lessons from a Mentor-Mentee Relationship

Deborah Hanuscin, University of Missouri
Jane Hian, Hallsville School District, Missouri

While teacher educators have had some success in helping prospective teachers understand the nature of science (NOS), they have been less effective in helping prospective teachers teach NOS. Though several studies have alluded to impacts of various interventions on developing pedagogical content knowledge (PCK) for NOS, the nature, source, and development of PCK for NOS has not been investigated in any systematic way. This study attempts to address that gap by using a case study approach to identify critical incidents in the development of PCK for NOS of both a prospective teacher and science teacher educator. Analysis of data collected over a two-year period during their mentor-mentee relationship illuminates pedagogical dilemmas faced by a prospective teacher in enacting NOS instruction within a school culture of primarily "traditional" science teaching. A series of narrative vignettes are used to illustrate the way in which teaching NOS might be construed as "acts of rebellion," and the ways in which personal convictions and PCK interact. Interpretation of the vignettes from the perspective of the science teacher educator allows for reflection and self-study in regard to preparing

teachers to teach NOS. Implications for fostering the development of PCK for NOS in teacher education are discussed. Developing Pedagogical Content Knowledge for Teaching the Nature of Science: Lessons from a Mentor-Mentee Relationship

S9.9.4 Elementary Teachers' Views on the Nature of Science: A Comparison of Inservice and Preservice Teachers

Minsuk K. Shim, University of Rhode Island
Betty J. Young, University of Rhode Island
Judith Paolucci, Narragansett Schools

Nature of science (NOS) refers to the epistemology of science including values and beliefs inherent in science and its development through scientific inquiry. Various national science reform initiatives have identified NOS as a critical element in scientific literacy. This study examined the differential views on NOS between 348 inservice and 110 preservice elementary teachers. NOS views were measured by a survey instrument, adopted from the Student Understanding of Science and Scientific Inquiry (SUSSI) instrument, having four distinctive scales showing reasonable reliability: observations/inferences, social/cultural influences, imagination/creativity, and scientific method. In addition, this study examined whether preservice teachers' views of NOS change after a science methods class that focuses on inquiry-based science instruction. Preservice teachers before the methods class did not have different NOS views from inservice teachers. However, after the class, preservice teachers showed significant changes in their views on NOS and their views were significantly different from those of inservice teachers. After the methods class, preservice teachers showed significantly more contemporary NOS conceptions in scientists' use of imagination/creativity and scientific methodology. Such NOS views were not influenced by these teachers' preference of teaching science or their experience teaching science using science kits.

S9.10 Strand 7—SC-Paper Set: Curriculum, Practice, and Instruction

S9.10.1 Preservice Elementary Teachers' Adaptation of Science Curriculum Materials and Development of Pedagogical Design Capacity for Inquiry-Oriented Science Teaching

Cory T. Forbes, University of Michigan
Elizabeth A. Davis, University of Michigan

Multiple methods are employed to investigate how preservice elementary teachers engage in curriculum design for inquiry-oriented elementary science teaching. Data collection involved 46 preservice elementary teachers in an undergraduate elementary science methods course and four preservice teachers from this larger group studied in-depth during the methods semester and student teaching semester. This study is informed by research on the teacher-curriculum relationship and is grounded in cultural-historical activity theory. Results suggest that preservice teachers can learn to adapt existing science curriculum materials to better align with tenets of scientific inquiry as articulated in contemporary science education reform. However, teachers' self-efficacy and preferences for science teaching, as well as their science background, have little influence on their capacity to do so. Rather, the curriculum materials themselves serve as the most significant factor in their curriculum design for inquiry-oriented science teaching. However, the use of these resources, as well as the curriculum design process, is socially- and culturally-mediated by the university and elementary classroom contexts of the teacher education program. These findings have implications for science teacher education and science curriculum development and contribute to the knowledge base in the learning science and science education.

S9.10.2 Guided Inquiry-Based Practical Work: The Possibilities of Inquiry In Everyday Elementary Science Classrooms

Mijung Kim, National Institute of Education, Singapore
Christine Chin, National Institute of Education, Singapore

Teaching science as process can be used to encourage students to learn science as questioning and knowing about the world. However, there has been a significant number of studies that discuss difficulties of practical work and inquiry – these involves internal (lack of knowledge, beliefs and attitudes) and external issues (constraints with time, curriculum, and classroom structure) in science classrooms. To overcome elementary preservice teachers' difficulties of inquiry-based learning, this study aimed to develop a localized context of inquiry-based teaching in Korean urban situations and to encourage preservice teachers to practice practical work and inquiry-based learning in this context. The study was conducted in an elementary science methods course involving 25 third year students majoring in elementary physical education. Mixed methods (survey questionnaires, reflective writing, and group discussion) were employed for data collection. Findings showed preservice teachers held negative perceptions toward teaching inquiry in schools. To overcome negative attitudes, this study proposed a framework of accessible inquiry-based learning through practical work in everyday classroom practice.

It suggests the possibilities of inquiry practical work through a) reexamining idealized forms of inquiry and b) understanding sets of certain knowledge and skills of practical work in order to increase confidence toward inquiry-based practical work.

S9.10.3 Swirling Discourses: Using a Discourses and Communities Framework to Situate Elementary Preservice Teachers' Use of an Instructional Model to Plan and Teach Science

Kristin L. Gunckel, University of Arizona

The Inquiry-Application Instructional Model (I-AIM) is a tool designed to help elementary preservice teachers use the curriculum materials they have available to plan science units that engage students in scientific practices and leverage the resources that their particular students bring to learning science. How preservice teachers use tools such as the I-AIM to plan and teach science is mediated by many factors, including their beliefs about teaching, their relationships with their mentor teachers, and their understanding of reform-based teaching. These mediators, however, are not merely characteristics of individuals, but are situated in the many Discourses (Gee, 1999) that preservice teachers encounter in the various communities in which they participate as they learn to teach elementary science. This paper provides an overview of five Discourses that emerged as sources of mediators for three preservice teachers as they used the I-AIM tool to plan and teach science in their field placement classrooms. This paper contributes to the development of a theoretical framework for understanding preservice teachers' experiences in learning to use tools and scaffolds to plan and teach science.

S9.10.4 Content-Area Literacy in New Teachers' Secondary Science Classrooms: Challenges and Possibilities

Ann E. Rivet, Teachers College Columbia University
Audrey Rabi Whitaker, Columbia University

Literacy and science learning are inextricably linked. Yet studies show that secondary students' literacy skills are lacking and new teachers are ill-equipped to address them in support of science learning, especially in high-stakes assessment environments. We present study of three new science teachers who completed a science preservice initiative in content-area literacy. Through weekly classroom observations, debriefing interviews and reflective interviews throughout their first year in the classroom, we examined their views of content-area literacy, their use of literacy strategies in their science instruction, and discussed several challenges they face with respect to literacy in their first year of teaching. This work provides much encouraging evidence to support pre-service secondary science teachers in developing understandings, tools, and strategies to address issues of content-area literacy in their future science classrooms. Recommendations from this study highlight the need for pre-service programs to provide not just theoretical but also a wide range of practical classroom-based examples of literacy tools and strategies at work in science instruction.

S9.11 Strand 8—SC-Paper Set: Teaching in Context

S9.11.1 Changing the Way of Teaching through Professional Development in Learning Communities: The "Biology in Context" Program

Doris Elster, University of Kiel
Lücken Markus, University of Kiel

Biology in Context (bik) is a three years lasting German program that aims at the improvement of biology teaching at the secondary school. Based on the national educational standards, science education researchers, representatives of the educational administration and teachers (N=146) work together on ten learning communities to transform this framework of context - and competence orientation into teaching and learning practice. The process of teacher professionalism was evaluated in a formative way. Quantitative data is available from the start of the project and from two follow-up tests and of the whole regular meetings of the learning communities. In addition, structured interviews were conducted with teachers (N=37), researchers (N=6) and coordinators (N=10) at the initial part of the project, one year later and at the end. The results concerning the process of teacher professionalism revealed that teachers increasingly reflect upon their classroom behaviour and cooperate with the other members of their learning communities. In general, bik was quite successful in changing biology classroom activities into more competence-oriented biology education. The success of the program depends on being able to sustain the partnership between educational researchers and teachers. This calls for the cultivation of the ongoing relationships between teachers and researchers.

S9.11.2 The Impact of a Teacher Professional Development Workshop on Perceptions of Design, Engineering, and Technology Activities for Integrated Curriculum

Karen A. High, Oklahoma State University
Pasha D. Antonenko, Oklahoma State University
Susan L. Stansberry, Oklahoma State University
Rebecca L. Damron, Oklahoma State University
Gayla J. Hudson, Oklahoma State University
Jean E. Dockers, Oklahoma State University
Alonzo F. Peterson, Langston University

This paper discusses the impact of a two-week professional development workshop on implementing cross-disciplinary design, engineering, and technology (DET) activities on middle level teachers' perceptions of the value and use of this methodology in the classroom. Results of the pre- and post-survey demonstrate that the workshop was effective in terms of enhancing teachers' familiarity with DET, their confidence about integrating DET, and importance of integrating DET activities in the middle level curriculum. The paper also discusses factors that predict teachers' views on DET, teachers' perceptions of the characteristics of a typical engineer, and beliefs on what the students need to understand as a result of learning via DET activities. This work is also novel in that the workshop integrated the DET activities not only in science, but also math, language arts, technology/multimedia, and social studies content areas. This was done with multidisciplinary teams of teachers using problem based learning curricula. Additionally, an online community and follow up days were scheduled to enhance implementation of DET integrated curriculum into the classroom.

S9.12 Strand 8—SC-Paper Set: Enacting Reform

S9.12.1 Use of Children's Literature by K-12 Teachers in a Science Inquiry Unit

Susannah K. Sandrin, UW Oshkosh
John Lemberger, UW Oshkosh
Peter M. Meyerson, UW Oshkosh

Seventy-two in-service elementary and secondary teachers participated in a weeklong summer workshop designed to help them use children's literature to teach science topics as inquiry. Teacher participants designed their own classroom inquiry units after learning about the essential features of inquiry and participating in inquiry units designed by course instructors. The overarching question addressed by the research summarized herein is "how did teachers use children's literature in designing an inquiry unit during a professional development workshop focused on children's literature and inquiry science?" Open coding revealed five primary categories of usage: (1) to anchor the topic by generating interest and introducing it, (2) as a science content tool during the data collection phase of the inquiry project, (3) to reinforce ideas and science content at the end of the unit, (4) to generate questions, and (5) to bring up misconceptions or claims made by the literature that the class could investigate. The data suggest that many of the teachers who took this course for the first time experienced difficulty with incorporating children's books to generate questions or investigate misconceptions and claims contained in the books.

S9.12.2 Lesson Plans and Science Education Reform: Is there a Connection?

Barry W. Golden, Florida State University
Yavuz Y. Saka, Florida State University
Patrick J. Enderle, Florida State University
Sherry A. Southerland, Florida State University
Given that science education has placed great emphasis on both lesson plans and on reforming K-12 education, there is little literature that actually addresses the intersection of these two issues. We argue that if reform is important in the community of science education, then the resultant interaction of reform on the development of lesson plans should be underscored. This qualitative research examined the ideas and uses of lesson plans as shown by four reform-oriented and four traditionally-oriented science teachers with varying degrees of experience. Our results show several significant differences, including differences in the need for flexibility and purposes of the lesson plans themselves.

S9.12.3 Understanding the Process of Applying Inquiry Teaching Methods in Elementary Classrooms

Michele J. Hollingsworth Koomen, Gustavus Adolphus College
High School Science Teachers' First Experience Teaching ELLs: A Year-Long Multiple Case Study
Karleen R. Goubeaud, Long Island University

This paper reports on an interpretive study of four elementary teachers who completed a two week long professional development course aimed at improving teacher understanding of insect ecology and developing inquiry learning opportunities in their classrooms. Two fundamental data collection methods of qualitative research (teacher observations and interviews) framed the data collection of this study. The primary method of investigating and analyzing the experiences of the teacher participants was grounded theory. Findings from the data analysis suggest that implementing inquiry in the first year after completion of the professional development was more teacher directed than student directed. The teacher in effect asks the questions, decides on the methods for experimentation and inquiry and makes the decision regarding the correctness or appropriateness of the answers. This paper extends our knowledge of inquiry-based teaching by placing the findings within a model of inquiry that is a spectrum rather than a linear model.

S9.13 Strand 10—Strand Invited Symposium: International Perspectives on Impacts of National Science Content Standards on Science Curriculum and Assessment Practices

David F. Treagust, Curtin University of Technology, Australia
Larry D. Yore, University of Victoria, Canada
John A. Anderson, University of Victoria, Canada
Todd M. Milford, University of Victoria, Canada
Justin Dillon, King's College London
Angelo Collins, Knowles Science Teaching Foundation

Over the past two decades, many countries have created or revised their national science content standards or the equivalent (e.g. programs, curriculum framework). These national content standards were created in specific national contexts and intended for specific purposes. A decade or more after the content standards were created, it is significant to examine how the intended purposes of science content standards have been met. Participants in this session represent four countries: Australia, Canada, United Kingdom, and United States. Based on their personal reflections, observations, and critiques, the participants will describe their national contexts for the content standards, intended purposes, and impacts (both intended and unintended) the content standards have been making in relation to curriculum and assessment practices in their countries.

S9.14 Strand 11—SC-Paper Set: Mentoring, Socialization, and Career Pathways

S9.14.1 Coteaching as Engaged Pedagogy: Transforming Science Teacher Education through Shared Responsibility

Christina Siry, CUNY
Sonya N. Martin, Drexel University

The increasing standardization of education, the prevailing culture of accountability in teacher education, and the accompanying deprofessionalization of the teacher that is evident in policy mandates and the proliferation of scripted curriculums presents a grand challenge to science teacher educators. We offer a theory generative account of how our utilization of engaged pedagogy, as analyzed from feminist and critical theory lenses, is making a difference in our teaching and in our students' classrooms. We intend through this presentation to explore the implementation of coteaching and cogenerative dialogue as a model for sharing responsibility for teaching and learning with our students as a form of engaged pedagogy. Our research demonstrates that sharing this responsibility fosters a sense of professionalism and awareness in our students, which enables them to be critical of national policies, school/district decision-making processes, and their own teacher education programs. We also examine the ways in which these coteaching experiences are simultaneously providing us with a critical lens with which to view our own teaching in two different science teacher education programs. In examining and confronting power and authority, coteaching-cogenerative dialogue offer researchers and teacher educators a methodological and theoretical framework for countering these national trends.

S9.14.2 Crafts(wo)men and Guilds: Expertise Development Among Science Education Researchers

John Settlage, University of Connecticut
Adam Johnston, Weber State University
Julie Kittleson, University of Georgia

The development of science education researchers is studied in a specific professional development context at a national conference. Emerging professionals in the field of science education are likened to those who undergo and apprenticeship to learn a craft. In this context, the essential themes of Critical Review, Joint Responsibility, and Practice Community are revealed by science education professionals, and implications for the use of these themes are described.

S9.14.3 Eye of the Beholder: Gender and Perceptions of Mentoring in Science Education

Susan A. Nolan, Seton Hall University
Cecilia H. Marzabadi, Seton Hall University
Janine P. Buckner, Seton Hall University

We will present results of two studies that compared women's and men's retrospective perceptions of the mentoring they received during their undergraduate, graduate, and post-doctoral training in science, technology, engineering, and mathematics (STEM) fields. The first study surveyed 455 graduates (135 women) who received doctoral degrees from 11 top U.S. chemistry programs over a 5-year period (1988-1992). The second study surveyed 149 graduates (28 women) who received doctoral degrees from 10 top U.S. programs in physics, mathematics, chemical engineering, or electrical engineering over that same time period. In both studies, graduates completed surveys that queried their perceptions of their training experiences. In line with Social Cognitive Career Theory (Lent, Brown, & Hackett, 1994), which posits that perceptions of educational barriers can affect career decisions, results suggest that, in general, women perceived that they received less mentoring than men at the undergraduate, graduate, and post-doctoral levels of training, likely related to gender differences in eventual career success. Specifically, with respect to their advisors, female participants were more likely to cite interest (a supervision/oversight model) whereas male participants were more likely to report support (a collegiality/mentorship model). Possible interventions at the individual and institutional levels are discussed.

S9.14.4 Sustaining Women in Physics, Chemistry, Mathematics, and Computer Science through Graduation

Barbara A. Burke, California State Polytechnic University
Dennis W. Sunal, University of Alabama

This paper reports a study of an intervention model aimed at increasing upper division women's graduation rate in physics, chemistry, mathematics, and computer science at a Hispanic Serving Institution (HIS). Using a model focusing on mentoring, a support network, and the development of a personal professional identity, the study identifies factors associated with sustaining academic progress for the 25 targeted undergraduate women. Findings are based on quantitative and qualitative data gathered via focus group interviews and analysis of student and faculty materials and artifacts. Results include positive findings in the areas of: providing students with meaningful and real life problem situations; building long term deep student and faculty interactions; expanding students' perceptions of the discipline and career; improving students' confidence providing time for professional socialization; providing experiences in challenging research, professional writing, and professional presentations; and creating a learning community of peers. The factors supporting the intervention components and strategies aimed at sustaining academic progress in this model can be tested in other settings and used to advance the success of undergraduate women, as well as other underrepresented groups, at this and at other similar institutions serving diverse student populations.

S9.15 Strand 12—SC-Paper Set: Cognitive and Attitudinal Impacts of Virtual Learning Experiences

S9.15.1 Measured and Perceived Cognitive and Motivational Effects of a Virtual Scientist Mentor

Catherine D. Bowman, Raytheon/NASA Ames Research Center
Diane Jass Ketelhut, Temple University

The creation of student-scientist partnership (SSP) programs represents one response to the challenge of providing greater attention to scientific literacy and science inquiry in schools. However, SSPs are both resource-intensive (requiring access to scientists and laboratories) and difficult to scale up, resulting in limited application and scope. Science inquiry programs (SIPs), a modified form of the SSP concept, offer a larger number of students with opportunities to actively engage in real investigations of their own design in classroom settings. While SIPs help increase the number of students involved in science inquiry, the programs often lack the mechanisms for providing students with more than a brief exposure to professionals in the field—potentially limiting the cognitive and affective gains realized through engagement with a scientist mentor. New advances in computing and educational technologies offer an alternative to direct contact with a scientist mentor through the instructional design of animated pedagogical agents (APAs). This mixed-methods dissertation study examines whether technology in the form of APAs provides benefits similar to working with a scientist mentor in SSP programs without the temporal and logistical costs associated with students working one-on-one with an actual scientist.

S9.15.2 Analyzing Predictors of Learning through Student Self-Efficacy in a Technology-Based Project

Len A. Annetta, North Carolina State University
Shawn Y. Holmes, North Carolina State University
Meng-Tzu Cheng, North Carolina State University
Elizabeth Folta, North Carolina State University
James A. Shymansky, University of Missouri
Richard Lamb, North Carolina State University

Much of the time spent out of school by today's students revolves around video and computer games. Evaluating learning with technology in an authentic learning environment is nearly impossible. However, evaluating efficacy and variables of the like that indicate and predict learning is one strategy to isolate the potential impact of technology. This study, part of a National Science Foundation funded project, evaluated self-efficacy of 544 students in grades 5-9 in North Carolina. Using the Student Efficacy in Technology and Science (SETS), data was analyzed through linear regression. Results indicated that gender is a significant ($p < .05$) predictor of efficacy in two of the five subscales (video games and synchronous chat) of the SETS instrument. This presentation will discuss the implications for science teaching and urge the call for a more widespread inclusion of technology-based practice in science teaching.

S9.15.3 Real Conversations in Virtual Worlds: The Impact of Student Conversations on Understanding of Science

Janice L. Anderson, University of North Carolina

This paper presents the findings from case analyses of nine fifth-grade student pairs who participated in the Quest Atlantis computer game intervention. The goal of this study was to provide rich description of various urban classroom contexts where Quest Atlantis was used to facilitate communication and help students construct science knowledge around water quality concepts. The extensive data that were collected throughout the project provides an in-depth picture of how student learning unfolds over time. Further analysis looked specifically at how the pair talked or conversed during game play, their actions during conversation, and how the game seemed to support or not support their understanding of the concepts. Several assertions were inferred from the analysis and include: 1) the role of conversations within and outside of the context of the game; and 2) the support of the construction of arguments using both social and scientific data through the students use of scaffolds within and external to the game. The students saw the game as an exciting way to complete activities, with the data helping to confirm the positive impact of using computer games as a teaching tool.

S9.15.4 The Impact of Domain Knowledge on the Portability of Vicarious Learning to the Classroom

Scotty D. Craig, University of Memphis
Joshua K. Brittingham, University of Memphis
Joah L. Williams, University of Memphis
Trey Martindale, University of Memphis
Arthur C. Graesser, University of Memphis
Barry Gholson, University of Memphis

Deep-level reasoning questions have been shown to provide excellent scaffolding tools that facilitate knowledge acquisition in vicarious learning environments. In a study with eighth grade students that extending across eight class periods, a videos of a dialogue with deep- questions, videos of a monologue with deep questions omitted, and a standard classroom condition tested the effectiveness of this finding in classrooms. Conditions did not differ on most measures, but the dialogue outperformed classroom instruction on daily essay questions. Overall there was an effect in favor of the vicarious learning environments over standard classroom interaction. However, only students in the vicarious environments with deep questions condition outperformed students in the standard classroom conditions on daily essay tests. This finding provides more support for the deep-level reasoning questions effect in vicarious learning environments.

S9.16 Strand 13—SC-Paper Set: Preparing Teachers to Meet Standards for Nature of Science and Inquiry

S9.16.1 Linking Teachers' Understandings of Nature of Science and Scientific Inquiry with Instructional Ability: A Follow-Up Investigation

Judith S. Lederman, Illinois Institute of Technology
Kevin J. White, Illinois Institute of Technology
Norman G. Lederman, Illinois Institute of Technology

The purpose of this follow-up investigation was to track the relationship between teachers' understandings of NOS and SI and their ability to teach NOS and SI. The sample was 15 science teachers who were enrolled in courses on NOS/SI and Advanced Teaching Strategies. Based on a previous investigation, enrollment in these two courses were during sequential semesters as opposed to concurrently. Data collected included pre and posttests on the Views of Scientific Inquiry survey and the Views of Nature of Science survey. In addition, teachers' book reports and reaction papers related to short readings, were analyzed, along with videotaped lessons, lesson plans, and self-critiques. In a previous investigation limited success in enhancing the connection between knowledge of NOS/SI and instructional ability was noted when courses on NOS/SI and the teaching of NOS/SI were offered concurrently. This investigation clearly documented that the relationship is enhanced when coursework attention is temporally separated. The results indicated a strong relationship between the progression of teachers' understandings and their instructional practice. However, it was also clear that the development of classroom practice lags behind the development of knowledge.

S9.16.2 Overcoming the Difficulties of Inquiry through Coaching

Rudolf V. Kraus, Rhode Island College
Norman G. Lederman, Illinois Institute of Technology

The national science education standards require the presence of inquiry in the classroom. Yet inquiry occurs infrequently, and evidence of specific barriers to teaching with inquiry-based methods is emerging (Crawford, 2007; Roehrig & Luft, 2004). The adoption of reform curricula is often resisted by teachers and schools, but the literature suggests that coaching is an effective technique for fostering teacher change in other subjects (Joyce & Showers, 1980). This multiple-case study examined the introduction into urban high schools of an inquiry-based science curriculum utilizing full-time instructional coaches. It follows six teacher-coach pairs as they adopt this curriculum, asking: What difficulties are perceived by the teacher-coach pairs, both collectively and individually, as they introduce inquiry-based methods into their classrooms? How do the teacher-coach pairs respond (or fail to respond) to these difficulties? Data from observations, interviews, and quantitative instruments (VOSI, LSI) were triangulated within a naturalistic inquiry (Lincoln & Guba, 1985) approach showing that coaching overcame some problems commonly associated with the use of inquiry, including insufficient resources, and mitigated others, such as insufficient time. Unfortunately, data revealed other problems with inquiry-based science in an urban setting, including logistical difficulties. Overall, coaching successfully promoted change in the direction of inquiry.

S9.16.3 A Critical Review of Current U.S. State Science Standards with Respect to the Inclusion of Elements of the Nature of Science

William F. McComas, University of Arkansas
Carole K. Lee, University of Arkansas
Sophia J. Sweeney, University of Arkansas

This study determined which elements of the nature of science [NOS] occurred in a sample of current K-12 U. S. state science standards. Twelve Key Aspects of the Nature of Science [K-NOS] (Alshamrani, 2008) were used to identify and code the standards of 12 randomly selected states. The research team focused on identifying (a) which NOS elements were included in K-12 science content standards, (b) the distribution of NOS elements with respect to their inclusion in and across grade levels, (d) the frequency of inclusion of NOS elements and (d) exemplary key NOS standards. The results show that some elements of NOS are consistently included in state standards, such as the tentative and empirical nature of science, the role of collaboration in science, and the relationship between science and technology. However, other important NOS aspects were rarely included, such as the notions that science cannot answer all questions and that scientific knowledge is not entirely objective. The final results of the analysis of the 50 states will provide a picture of the agreement between the recommendations of the science community regarding key NOS ideas to teach K-12 students and the inclusion of NOS aspects in state science standards documents.

S9.16.4 Modeling Epistemic Practices in Science Teachers' Learning

Sibel Erduran, University of Bristol

A particular gap in the continuing professional development (CPD) literature concerns the use of epistemic practices of science as a model for CPD (Duschl & Erduran, 1996). Epistemic practices are the cognitive and discursive activities that are targeted in science education to develop epistemic understanding (e.g. Sandoval et al., 2000). These practices include the articulation and evaluation of knowledge; coordination of theory and evidence; making sense of patterns in data; and holding claims accountable to evidence and criteria. This paper reports a CPD project that targeted the modeling of epistemic practices among a group of teachers from various career stages. For instance, the teachers were asked to select, interpret and present evidence from their teaching in order to provide arguments for what worked and what didn't work. The project was conducted with 5 science teachers in a middle school in England between 2007-2008, and funded by the Training and Development Agency for Schools. The paper will report on (a) the CPD model, in particular the way in which the model engaged the teachers in epistemic practices of science; and (b) teachers' perceptions of the CPD model; (c) the overall impact of the CPD on teachers as well as pupils.

S9.17 Strand 15—Strand Invited Symposium: Quality Research, Policy, and Practice in Service of Science Education: Part 2—Lessons Learned

Yehudit Judy Dori, Israel Institute of Technology
Doris Jorde, University of Oslo, Norway
Jonathan Osborne, Stanford University
Richard Duschl, Pennsylvania State University
Marissa Rollnick, Witswatersrand University, South Africa
Hsiao-Ching She, National Chiao Tung University, Taiwan

This part of the symposium on public policy and science education will consider the lessons learned about goals, processes, and results from service on task forces, committees, and commissions and the resulting reports on science education. Brief presentations will address the charge, internal negotiations and deliberative processes, and the nature of the recommendations and any detected impact on public policy to date. Other panelists and participants will share their acquired insights into the issues outlined in Part 1 based on their service on royal inquiries, task forces, commissions, and government committees.

S10.1 External Policy Sponsored Session—Symposium: Part I—Math Science Partnerships (MSPs): Rising to the Grand Challenges of Bringing Contemporary Science to K-12 Teachers and Students and Providing Evidence of Impact

Amy Edmondson, Centralia Elementary School District (California)
Terry L. McCollum, Miami University (Ohio)
George Nelson, Western Washington University
Carolyn Landel, Western Washington University
Bill Schmidt, Michigan State University

Math/Science Partnerships (MSPs) are a federal policy focus of both NSF and USDOE, supported by the Clinton and Bush administrations, the National Science Board, and Capitol Hill. MSPs' goals are to improve discipline-specific teacher education and continuing professional development by involving scientists, engineers, and mathematicians directly in these activities, as they improve outcomes for underserved students, in particular. This symposium will feature four highly regarded MSPs funded by USDOE or NSF: • Collaboration for Success in Science Partnership (CSSP) strives to close achievement gaps between English language learners and students whose first language is English (California) • The Southwest Ohio Science Institutes (SOSI) uses summer institutes and on-line learning communities to improve teacher PCK and student learning • North Cascades and Olympic Science Partnership (NCOSP) is a K-12 partnership involving 25 disciplinary science faculty from 5 higher education institutions and K12 staff from 28 school districts. • Promoting Rigorous Outcomes in Mathematics/Science Education (PROM/SE) is a comprehensive R&D K-12 effort to improve mathematics/science teaching and learning, based on assessment of students and teachers, improvement of standards and frameworks, and capacity building This symposium will not only discuss the MSPs' accomplishments, focus on research and policy challenges that they have encountered.

S10.2 Research Committee Sponsored Session—Technology Symposium: Science Education for a Global Future: Why Aren't American Schools Measuring Up and What Can We Do About It?

Nancy Butler Songer, University of Michigan
Lea Bullard, University of Michigan
Tricia Jones, University of Michigan

Increasingly, there is a growing recognition that to remain globally competitive, countries will need to support and educate individuals that are literate in science and technology. The educational systems in the United States, however, do not seem to be embracing this perspective. Our analysis of one of the reasons American schools are not measuring up points to the lack of age-appropriate, guided activities focusing on complex reasoning in science and technology within American K-12 schools. This interactive presentation will present, and allow the audience to work/play with, three examples of technological tools that confront grand challenges to American global competitiveness in science and technology, with each tool illustrating new opportunities to combat this challenge. The presentation will conclude with a lively discussion of the interactive session, including speaker presentation of research results realized after seven years implementing three National Science Foundation-funded research programs utilizing these tools and focused on complex thinking in science and technology.

S10.3 Strand 1—SC-Paper Set: Understanding Space at the Elementary Level

S10.3.1 Comparing the Efficacy of Reform Based and Traditional/Verification Curricula to Support Student Learning About Space Science

Ellen Granger, Florida State University
Todd H. Bevis, Florida State University
Yavuz Saka, Florida State University
Sherry Southerland, Florida State University

This research investigates the effectiveness of Great Exploration in Math and Science (GEMS) curriculum in supporting 4th and 5th grade students' learning of space science. GEMS is employs an inductive approach to content (learning cycle), explicit use of evidence, and attention to scientific inquiry. A quasi-experimental design was employed with randomization occurring at the level of the teacher assignment to treatment group (GEMS or the district adopted text). Students' space science learning of concepts, views of scientific inquiry, knowledge of models/theories, and affective orientation to science were compared across GEMS and control groups both pre and post instruction. Student learning of space science content and affect toward science was greater in the 4th and 5th grade GEMS sections; the scores from the 4th and 5th control sections were lower than GEMS groups. These trends suggest that reform based instruction can be effective in supporting the learning of space science content.

S10.3.2 Children Explaining Celestial Motion: Development of a Learning Progression

Julia D. Plummer, Arcadia University
Cynthia Slagle, Colonial School District

Extensive research has shown that students' understanding of astronomy does not resemble the scientific view. This study builds on our previous research in the area of apparent celestial motion to examine how children develop an understanding of the connection between the apparent motions of the sun, moon and the stars in the sky and the explanation for these motions, using the earth's rotation and revolution. Pre and post interviews were used to assess changes in student understanding following instruction designed to present apparent celestial motion through computer simulations followed by modeling of the explanations. Significant improvement was found across most areas among the third grade subjects (N=16). The main purpose of this study was to begin the development of a learning progression for celestial motion and to test the use of this progression against the results of this instruction. The learning progression was created, through analysis of the domain, close examination of research on children's understanding, and the range of ideas expressed by students in this study. The progression was also found to be a useful scale, demonstrating the success of the instruction and providing insights for how future instruction may be improved to address students' alternative conceptions.

S10.3.3 Conceptual Understandings of Middle School Students' with Visual Impairments Concerning Seasonal Change

Tiffany Wild, The Ohio State University
Kathy Cabe Trundle, The Ohio State University

The purpose of this study was to understand and describe the misconceptions that may exist among students with visual impairments and instructional techniques designed to help them learn scientific concepts about seasonal change. Students were interviewed 1 week prior and 2 weeks after instruction, and data were analyzed using constant comparative methods. A total of 7 students participated in either a traditional type of instruction or an inquiry-based curriculum about causes of seasons. The traditional instruction included textbooks, lectures, and models. The instruction for the inquiry-based group included student generated models, graphs of temperature data, and surveys of family and friends. Students who participated in the traditional instruction all exhibited alternative conceptions before instruction and continued to exhibit alternative understandings of seasons after instruction. Only one student in this group held a scientific fragment (e.g., Earth orbiting the Sun) within his alternative explanation. Students who were members of the inquiry-based group also had alternative conceptions before instruction. One student was able to explain that the Earth orbited the Sun, but could not explain how this planetary motion caused seasons. After the inquiry-based instruction, students in this group had a more scientifically accurate understanding of seasons, and none held alternative understandings.

S10.3.4 A Three Year Longitudinal Study of Elementary Students' Understandings of Lunar Concepts Related to Moon Phases

Timothy R. Young, University of North Dakota
Mark D. Guy, University of North Dakota

Eleven students from an initial 3rd grade study and a 4th grade study participated as fifth graders in a third year investigation to determine to what extent a second instructional intervention after 1.5 years would impact students' scientific understanding of the cause of lunar phases. Two months after the instruction, the students were interviewed using the same research protocol as in the earlier studies. One student maintained scientific understanding and two students advanced in their conceptual understanding from alternative to scientific fragments with no alternative concepts. Two students regressed from a scientific understanding to alternative concepts while the six remaining students remained at the alternative conceptual level. Findings are discussed and implications are offered related to the prospect of identifying foundational or core concepts that may support more sustained conceptual understanding in astronomy.

S10.4 Strand 1—Symposium: Argumentation in Science Education: Current Challenges and Future Directions

Joseph Krajcik, University of Michigan
Katherine McNeill, Boston College
Douglas Clark, Arizona State University
Muhsin Menekse, Arizona State University
Cynthia DAngelo, Arizona State University
Sharon Schleigh, East Carolina University
Maria Evagorou, Kings College London

For the past decade, a focus on students' ability to engage in argumentation and to construct argument and explanations has been a significant feature of research in science education. This symposium, based on three papers from significant contributors to this body of work, will attempt to take stock of the achievements for the field and the future challenges that it faces. It will begin by offering an overview of the main highlights of the work in thisfield to date. Three papers will then explore those achievements in more detail and highlight the areas for further research and exploration. The first will look at what has been learnt from three years of work designing materials to support students in writing scientific explanations. The second will examine the use of schemas designed to generate conflict and how they can support argumentation. The final paper is a comparison of case studies to identify the features of pairs who are successful at engaging in argumentation. The focus will be on how to support teachers in scaffolding argumentation exploring questions such as what are the important features essential to constructing evidence-based explanations and what are the characteristics of a successful argumentation lesson?

S10.5 Strand 2—SC-Paper Set: Teaching and Learning Chemistry: Lessons from the Field

S10.5.1 Chemistry, Inquiry, and Distance Learning Do Mix! Learners Working as Scientists in an Online Course for Teachers

Mary V. Mawn, SUNY Empire State College

The online learning environment may seem intrinsically text-based. However, through inquiry and constructivist approaches, learners can be engaged in authentic learning experiences that integrate science content and process. Such online courses can provide alternatives for in-service teachers with limited options for professional development due to geographic remoteness, time, or both. This study investigates how inquiry fostered the learning of science content in an online chemistry course for teachers. Study findings reveal that teachers worked as scientists as they hypothesized, experimented, analyzed, and discussed fundamental chemical concepts. These teachers often extended their investigations, going beyond what was required by the course. Pre- and post-course surveys data showed significant gains in teachers' confidence for teaching these concepts to their own students.

S10.5.2 The Challenge of Teaching Chemistry Contextually: Achieving Resonance between Classroom Transactions and Real-World Fields

Donna T. King, Queensland University of Technology
Stephen M Ritchie, Queensland University of Technology

Curriculum developers and researchers have promoted context-based programs to arrest waning student interest and participation in the enabling sciences at high school and university. Context-based programs aim for student resonance between scientific discourse and real-world contexts to elevate curricular relevance without diminishing conceptual understanding. This ethnographic study explored the learning transactions in one 11th grade context-based chemistry classroom. In particular, the dialectic of agency½structure was used to examine how the schema and practices from students' lifeworlds resonated with the chemistry that was taught. The results suggest that when students use discourses of the sanctioned chemistry curriculum in the classroom in relation to another real-world field (i.e., investigating water quality at a local creek), students make connections between the canonical science and the real-world field. The study reveals that the structures of writing and collaborating in groups afforded students the agency to move between fields fluently, and at times populate both fields simultaneously. Research, teaching and policy implications of these results for promoting context-based science teaching are discussed.

S10.5.3 Efficiency of Tasks in Chemistry Lessons

Oliver Tepner, University of Duisburg-Essen
Burkhard Roeder, University of Dortmund
Insa Melle, University of Dortmund

Tasks can provide important tools for attaining and evaluating students' knowledge in classes. However, there is no evidence whether and on what terms they can be integrated in chemistry lessons effectively. In this study, tasks for the topic stoichiometry/chemical equations were developed as efficient as possible and afterwards their application was scrutinized. Using a quasi-experimental approach, students worked on tasks under certain conditions, like in plenum with the help of their teacher or autonomously on worksheets. The regarding samples have been compared by transforming pre and post test data into standardized residuals. For this purpose, respective test instruments for students' knowledge and attitudes towards chemistry and tasks have been developed. Using a so-called crossed parallel classes design eventual differences in confounding variables between intervention and control group should be compensated. Central findings are on the one hand the verification of constructing aspects for efficient tasks and worksheets like an explicit statement of task, a clear structure and a written handling. On the other hand, there are significant better results in knowledge and attitudes for the treatment groups compared with the control groups if tasks are applied in a systematic way and handled autonomously.

S10.5.4 Exploring the Impact of Differing Participant Structures in the Chemistry Classroom

Dennis W. Smithenry, Santa Clara University

This paper examines, from the students' point of view, the impact of changing the participant structure found in the typical high school chemistry classroom to one that is more student-centered. The impact was assessed through the administration of a survey to two student groups who had experienced differing participant structures. An analysis of the survey data revealed that the two groups held different perceptions about their classroom environment and their ability to collaborate. Significantly more of the students, who had experi-

enced the student-centered participant structure, felt that their classroom environment supported a strong sense of community where all students were expected to participate and work together with only minimal input from their teacher. These students also indicated that their experiences had helped them to learn a set of collaborative skills. These findings are important because they suggest the types of outcomes that we can expect from a participant structure that embodies the National Science Education Standards and more closely simulates scientific practice. They also lend support to the theoretical idea that changes in the classroom participant structure can lead to changes in what students learn.

S10.6 Strand 2—Symposium: What about Love? The Role of Emotions in Urban Science Education

Christina Siry, CUNY
Maria S. Rivera Maulucci, Columbia University
Nicole Grimes, CUNY

This symposium examines the role of love and other emotions in science education. Definitions of science often incorporate adjectives such as objective, rational, unbiased, reproducible, verifiable, and quantifiable. Love is not usually a part of that equation. On the contrary, subjectivity and emotionality are so far removed from the Eurocentric knowledge systems that have come to dominate conceptions of science that it might often be assumed that the teaching of science should follow suit. In conveying concepts and forms of data collection that are rigid and controlled, science educators can too often take on these same attributes in their approach to their subjects and to their students. Improved classroom performance, on the other hand, is often achieved when students are intrinsically motivated and can take ownership of their own learning. The presenters attempt to show how cogeneration of science education between teachers and their students can foster positive emotions such as love, which lead to greater emotional investment in more successful teaching and learning. This creates solidarity and establishes learning communities in place of the typical science classroom hierarchy.

S10.7 Strand 4—SC-Paper Set: Pedagogical Content Knowledge in Secondary Science

S10.7.1 Middle Grade Teachers Characterizations of Integrated Mathematics and Science Instruction

James Stallworth, University of Cincinnati
Helen Meyer, University of Cincinnati
Shelly Harkness, University of Cincinnati
Kevin Stinson, University of Cincinnati

The research reported here addresses two aspects of integrated mathematics and science instruction. We provide insights into how middle grades teachers' characterize integrated mathematics and science instruction. We also discuss how middle grades teachers see an integrated curriculum fitting into their teaching contexts. Data was gathered through the use of an open-ended survey and face-to-face interviews with middle grades teachers. Qualitative analysis techniques were used to independently analyze the survey and interview data. The results of the independent analysis were then compared. The research findings suggest that teachers draw upon a teaming model of integration when they are in their teaching contexts and this significantly differs from the models of mathematics and science integration found in the research literature.

S10.7.2 The First Three Years: How Context and Pedagogical Content Knowledge Affects the Use of Instructional Materials and Resources

Krista L. Adams, Arizona State University
Jonah B. Firestone, Arizona State
Julie A. Luft, Arizona State University
Jennifer J. Neakrase, New Mexico State University
EunJin Bang, Iowa State University University
Irasema Ortega, Arizona State University
Sissy Wong, Arizona State University

Teachers make curricular decisions daily. There are various factors that influence these decisions and range from state standards, to pedagogical content knowledge, and to the resources available at their schools. The teacher designs the lesson by choosing activities that make sense to their current understandings in pedagogy and subject matter. The activities may come from various sources such as textbook, Internet, and other teachers. These activities may require materials like worksheets, lab materials, and videos. Using the reported instructional materials and instructional resources of beginning science teachers, this follow-up study compares teachers in varying contexts including classroom demographics and the number of classes they must prepare to teach. This information was compared to the teacher's pedagogical content knowledge. Results found that teachers over the course of their three years relied upon the Internet and videos for classroom instruction and modified their lessons more frequently. A teacher's class diversity and assignments in terms of their use of instructional materials and resources does not appear to predict a persons' pedagogical content knowledge.

S10.7.3 A Comparison of Teachers' Demonstration of Pedagogical Content Knowledge While Planning In and Out of Their Science Expertise

Jenny D. Ingber, Columbia University
Ann E Rivet, Columbia University

Science teachers are often asked to teach multiple science classes, some of which may not be in the teachers science area of expertise. This study is intended to uncover how teachers in this situation use their pedagogical content knowledge to plan lessons both in and out of their area of expertise. Comparisons and contrasts are made in six teachers' planning process for teaching both in and out of her science area of expertise. The data for this study are the transcripts from think-aloud planning episodes, relevant curriculum planning materials and resources, and a survey. The data was organized into four main categories: 1.) the planning process and use of resources while planning; 2.) demonstration of science content knowledge while planning or in preparation materials 3.) demonstration of knowledge of students while planning or in preparation materials, and 4.) demonstration of multiple strategies for teaching the topics discussed and/or for assessing student understanding of the topics. Further research to determine how teachers use their knowledge at each level of planning, how novices plan for their area of expertise compares with an area outside of their expertise, and the implications for enactment of lessons are needed.

S10.7.4 Pedagogical Content Knowledge in High School Chemistry: Teacher Efficacy, High Stakes Standardized Testing, and Student Outcomes

Angela M. Kelly, City University of New York
Lauren Marcinowski, City University of New York
Ari Leventhal, City University of New York

In the current climate of science education reform and high stakes testing, many out-of-school programs have proliferated, particularly in urban areas, to promote achievement among students who have experienced failure in traditional school settings. Such programs require skilled science instruction, or pedagogical content knowledge, to represent the subject matter in ways that promote meaningful understanding and conceptual change for underserved youth. This study examines the characteristics of PCK demonstrated in an urban summer chemistry program for high school students. A mixed methods approach was utilized to examine the pedagogical strategies of three lead teachers in the program setting. Videotaped lessons were analyzed for characteristics of highly effective PCK, and student achievement was measured through observed classroom behaviors and standardized test performance. Findings suggest that highly developed PCK is directly related to student achievement, although such skilled teaching methods do not seem to be necessary for the low proficiency standards required for passing state high stakes tests.

S10.8 Strand 5—SC-Paper Set: Chemistry, Thought, Pedagogy, and Curriculum

S10.8.1 Teaching Quantum Mechanical Concepts via the Learning Unit "From Nano-scale Chemistry to Microelectronics"

Vered Dangur, Technion - Israel Institute of Technology
Uri Peskin, Technion - Israel Institute of Technology
Yehudit Judy Dori, Technion - Israel Institute of Technology

From nano-scale chemistry to microelectronics is a new learning unit that focuses on quantum chemistry, developed for both undergraduate and high-school chemistry students. The research objective was to investigate the effect of the unit on development of conceptual understanding among undergraduate and high-school chemistry students. Research participants included 82 undergraduates, who studied the advanced quantum chemistry course and volunteered to participate in the research, and 198 12th grade chemistry students, who studied the unit. The research tools included pre- questionnaire and post-questionnaire. Undergraduate students who were exposed to the learning unit improved their understanding of chemistry and ability to explain an illustration, at a level higher than students who were not exposed to the learning unit. Most of the high-school students expressed in their responses a shift to the quantum model, but some of them still pronounced misconceptions and previous naïve models even after learning the unit. The four chemistry understanding levels – macro, micro, symbol and process – were used in the research as an assessment tool for identifying chemistry understanding. As an outcome, an additional level of understanding has been proposed: the nano-structure level. This research contributes to the body of knowledge of visualization and thinking skills in chemistry.

S10.8.2 College Students' Use of Learning Strategies and Their Anxiety Levels in Chemistry

Betul Demirdogen, Zonguldak Karaelmas University
Esen Uzuntiryaki, Middle East Technical University
Yesim Capa Aydin, Middle East Technical University

The purpose of this study was to investigate the relationship between anxiety variables and use of learning strategies among college freshmen students in chemistry. Motivated strategies for learning questionnaire, chemistry anxiety scale, and chemistry laboratory anxiety scale were used as data collection instruments. Five hundred sixteen college freshmen students from three different universities who were taking or have already taken introductory chemistry course participated in the study. Canonical correlation analysis was used for analyzing the data. Results showed that rehearsal and peer learning were positively related with anxiety variables, whereas time and study environment and effort regulation were negatively related with those variables. Suggestions for further research were provided.

S10.8.3 An Exploration of Practitioner Development in Organic Chemistry: The Role of Reaction Mechanism Problem-Solving Skills

Jason P. Anderson, Purdue University
George M. Bodner, Purdue University

Organic chemistry is well known for its common student difficulties, especially mechanistic descriptions of reactions. Reaction mechanisms and the associated electron-pushing formalism are a symbolic language used to discuss the reactivity and demonstrate the predictability of problems common to organic chemistry. Practitioners freely navigate this language; however, it is often misunderstood and poorly applied by novice organic chemists. This disconnect was at the center of the study discussed in this paper and it was the goal of this research to determine how advanced-level organic students' mechanistic thinking and problem-solving strategies developed as they became members of the organic chemistry research community. For this, we utilized a constructivist perspective combined with situated learning theories to guide the probing of their development. The qualitative data collected in the form of interviews, observations, written artifacts, and field notes were then analyzed through an ethnomethodological lens to focus on the participants sense- making processes encountered in everyday activities situated within an authentic learning environment. Results indicated that the graduate student participants' research experiences – and associated troubleshooting in research – contributed immensely to their mechanistic development and transition from student to practicing organic chemists.

S10.8.4 Constrained Reasoning: Mental Shortcuts Used by Chemistry Students

Jenine Maeyer, University of Arizona.
Vicente Talanquer, University of Arizona.

A significant proportion of the questions and problems that students face in a chemistry class demand making comparisons, drawing inferences, and making qualitative predictions about the properties of chemical substances. In particular, in this research study we were interested in investigating the reasoning strategies used by undergraduate chemistry students when asked to rank different chemical compounds based on the expected relative value of a single physical (boiling point, melting point, or solubility) or chemical (acid or base strength) property. Our mixed-methods research design included both the application of a questionnaire and individual interviews. Our results indicate that many of the students' answers result from the application of four main reasoning heuristics: Association, Familiarity, Similarity, and Trend. Students tended to use fewer than three of these strategies per question. Association was the most frequently used type of heuristic. However, for questions that included common substances, such as NaCl and HCl, the use of the Familiarity heuristic was predominant.

S10.9 Strand 6—SC-Paper Set: Examining Learning in Exhibitions

S10.9.1 Learning as a Family at the Zoo

Loran C. Parker, Purdue University
Gerald H. Krockover, Purdue University

In the last twenty years, research about science learning in informal contexts such as museums, science centers, zoos and aquariums has proliferated. Researchers have primarily viewed informal science learning from a social constructivist perspective. This framework for science learning may not best capture the complexity of science learning at museums, science centers, zoos and aquariums. The science learning that takes place may be better describe by viewing the visiting group as a learning collective, rather than a group of individual science learners. My study applies this understanding of science learning as a collective praxis to the context of informal science learning at a community zoo. Learning at an informal institution such as a zoo has not been viewed through this lens. Specifically, my driving research question is: How do families draw upon and use available resources to learn science at a Midwestern community zoo? Through videotaped observation of family visits to a community zoo I found that families with similar backgrounds approach learning at the zoo very differently and often do not attend to the educational goals that the zoo has designed for each exhibit, rather they negotiate their own curriculum that focuses on their immediate experiences.

S10.9.2 Measuring Emotion at an Urban Science Center

Katie L. Gillespie, Oregon State University
John H. Falk, Oregon State University

We studied emotion at a special exhibit developed by the California Science Center (Los Angeles, CA), called Goose Bumps: The Science of Fear, which was designed to let visitors experience the emotion of fear. The purpose of this research was to determine whether: 1) emotion could be validly and reliably measured in a science center: 2) the Goose Bumps exhibit increased visitors' emotional level; and 3) elevated emotion enhanced visitors' cognitive science learning. Interviews were conducted with a random sample of 145 Goose Bumps exhibit visitors and 84 control visitors not attending the exhibit. Russell's Affect Grid, a laboratory validated instrument, was used to measure emotion. According to Russell's circumplex model, emotion can be measured along two dimensions: arousal (alertness) and valence (pleasure). A delayed-post interview was conducted four months later with visitors from both groups. Results from the initial interviews indicated that Goose Bumps visitors were more aroused than controls. In delayed-post interviews, Goose Bumps visitors demonstrated significantly greater recall and learning than did controls. Results suggested that emotion may in fact be measurable and could be manipulated as a significant variable in free-choice learning settings.

S10.9.3 Accessing and Incorporating Visitors' Entrance Narratives Enhances Guided Museum Tours

Dina Tsybulskaya, The Hebrew University of Jerusalem, Israel
Jeff Dodick, The Hebrew University of Jerusalem, Israel
Jeff Camhi, The Hebrew University of Jerusalem, Israel

Museum visitors arrive at an exhibit or tour with their own individual experiences, memories and knowledge related to the subject—their "entrance narrative" (EN). We tested the effect, on participants in guided tours, of the guide first accessing—by two different methods—the ENs of their visitors, and then making specific connections between these and the content of the tour. The subject of the tour was a guided tree walk at a research university's "open-campus museum." Both behavioral measures and questionnaires indicated that accessing and incorporating participants' ENs profoundly enhanced their experience. The enhancement was somewhat greater among visitors from the general public than among groups of university students. We suggest that guides could use the simple methods described here, in a wide variety of tour types, to enhance visitor experiences.

S10.9.4 How Does Content Delivered Via Handheld Computers Mediate Visitors' Action at an ISEA?

Molly E. Phipps, Science Museum of Minnesota

This study examines the impact of a program using iPods on visitors' activity surrounding an exhibit on scientific chaos. Following a naturalistic inquiry process with iterative coding cycles I developed four "situation definitions" (Goffman, 1959) under which visitors interact with the exhibit without the iPods. The four situation definitions are: "HOW DOES IT WORK?", "WAITING FOR THE SPLASH", "INTERACTING", and "RESTING". I used these situation definitions to analyze video recordings of participants using the iPods at the exhibit and to compare those who used the iPods and those who did not.

S10.9.5 Macro-Scale Structure of Activity Aquarium Touch Tanks: Examining Visitor Engagement through Talk and Action

Shawn M. Rowe, Oregon State University
James Kisiel, California State University, Long Beach

This presentation reports on the first phase findings of a two-year research project on visitor engagement with touch tanks at four aquariums on the west coast of the United States. Touch tanks containing marine and aquatic vertebrates and invertebrates are a ubiquitous and popular feature of public, informal science venues. Although research suggests that touch tanks may engage people emotionally, few studies have attempted to understand the characteristics of this engagement or examine what factors might improve these experiences.

Two research questions guide the whole project: 1) What kinds of talk and interactions with objects characterize visitor engagement with touch tanks? and 2) To what extent do different variables shape visitor engagement and reported experience outcomes in these complex settings? Several types of talk and action common across different families and different sites are detailed, and special attention is paid to the role of touching and naming for participants. Implications for aquariums, zoos, and researchers working in informal education settings are discussed.

S10.10 Strand 7—SC-Paper Set: The Development of Pedagogical Content Knowledge in Preservice Teachers

S10.10.1 Improving Preservice Science Teacher Education at University by Means of Special Exercise Tasks – An Attempt Based on Generative Learning Theory

Michael Germ, Ludwig Maximilians University of Munich, Germany
Andreas Mueller, University of Koblenz-Landau, Germany
Ute Harms, University of Kiel, Germany

Teacher students must be given opportunities to relate their general pedagogical knowledge to their subject matter knowledge with respect to the teaching of their specific subject. A lack in such integration leads to the acquisition of rather isolated knowledge components, which constrains the development of pedagogical content knowledge (PCK) as a professional basis for science teaching. As exercise tasks in instructional settings are regarded a helpful means to support knowledge acquisition, in this study special exercise tasks were developed for biology teacher education based on the model of generative learning. These tasks should help the teacher students to consolidate their knowledge about basic pedagogical and psychological concepts in terms of teaching biology. A selected part of this task pool was evaluated in university courses of biology teacher education, collecting data by different methodological approaches: the qualitative analysis of the students' answers to the tasks, a pre-posttest-designed questioning of the participants, and the use of specific task-related questionnaires. By this means, particular difficulties in dealing with the tasks could be identified. Furthermore, the results indicate that working with the tasks positively affects the construction of usable knowledge and facilitates the connection between the different disciplines of biology teacher education.

S10.10.2 Developing Technological Pedagogical Content Knowledge (TPCK) of Pre-Service Science Teachers through a Peer Coaching Model

Syh-Jong Jang, Chung-Yuan Christian University, Taiwan

This study examined the effects of a peer coaching model for enhancing technological pedagogical content knowledge (TPCK) of pre-service science teachers. A TPCK-COPR model (Comprehension, Observation, Practice and Reflection) was designed to restructure science teacher education courses. Participants of this study included a single instructor and a group of pre-service teachers (n=12). The main sources of data included online data, reflective journals, videotapes and interviews. The finding of this study expanded four views to explore the teaching and assessment of TPCK, namely, the comprehensive, imitative, transformative and integrative views. The results showed that pre-service teachers were clearly comprehensive of students' prior conceptions of the subject matter and their learning difficulties. Furthermore, pre-service teachers could imitate and transform TPCK through teaching observation and practice. They reflected that they had learned how to integrate technologies with teaching through the online learning environment and the peer coaching model. The teaching model could help pre-service teachers develop technological pedagogical methods and strategies of integrating the subject-matter knowledge into science lessons, and further enhanced their TPCK.

S10.10.3 Preservice Teachers' Topic-Specific Pedagogical Content Knowledge for Teaching the Concept of Dissolving

Karthigeyan Subramaniam, Pennsylvania State University

The purpose of this study was to investigate elementary preservice teachers' topic-specific PCK for teaching dissolving. The "academic construct" of PCK was used to frame how participants' explained, demonstrated and rationalized their teaching strategies for teaching the concept of dissolving. Data were collected using a variety of qualitative methods: observation notes, surveys, audio-taped recordings, focus group transcripts and artifacts. Findings revealed that participants' subject matter knowledge consisted of specific alternative conceptions of dissolving that impacted participants' topic-specific pedagogical knowledge for teaching dissolving. In addition, participants' foundation of topic-specific PCK for dissolving in this study was an oversimplified modification of their misconception-laden subject matter, pedagogical knowledge and contextual knowledge. Implications are two-fold. First, methods instructors, educational researchers, and curriculum developers need to plan and implement purposefully selected science learning experiences within methods courses that

will impact preservice teachers' developing pedagogical content knowledge. Second, , methods instructors, and educational researchers need to acknowledge that preservice teachers' come to teacher preparation programs with thought processes that contain both scientifically accepted conceptions, and alternative conceptions that directly or indirectly affect their developing topic-specific PCK.

S10.10.4 Changes in Beginning Secondary Science Teachers' PCK for Instruction

Mark J. Volkmann, University of Missouri, Columbia
Patrick L. Brown, Washington University, Missouri
Andrew B. West, University of Missouri, Columbia
Deanna M. Lankford, University of Missouri, Columbia
Sandra K. Abell, University of Missouri, Columbia

Traditional science instruction consists of informing students of what they are expected to know. This traditional, teaching-as-telling approach, is held by prospective science teachers (Mellado, 1998), as well as experienced science teachers (Sanchez & Valcarcel, 1999). Reform-based pedagogy (NRC, 2000) engages students in predicting, testing, finding patterns, and building explanations. The influence of science methods courses to help preservice and beginning teachers to change to a reform-based pedagogy is unclear. Zembal-Saul, Blumenfeld, and Krajcik (2000) found that science methods courses help pre-service teachers improve how they organize instruction. Zeichner & Gore (1990) and Marion et al. (1999) found that beginning teachers were unable to implement reform-based pedagogy. The purpose of this 2-year study was to learn how science teaching interns in an alternative certification program sequence science instruction, how their sequence changed, and what sources they drew upon as they made these changes. We found that some beginning teachers were able to change their practices in reform-minded ways (6 of 8) and some were not (2 of 8). The teachers who changed suggest ways to reform teacher education programs.

S10.11 Strand 8—SC-Paper Set: Efficacy of Professional Development

S10.11.1 Co-Evolution of Practice and Pedagogy: A Model for Science Teacher Change in the Context of Professional Development

Ian D. Beatty, University of Massachusetts Amherst and University of North Carolina at Greensboro
Allan Feldman, University of Massachusetts Amherst

We present a model for how science and mathematics teachers change their views, skills, and instructional practices in the context of an intensive, sustained professional development (PD) program. 43 teachers from three school districts, including 30 high school and 13 middle school teachers, are participating in multi-year PD designed to help them integrate the Technology-Enhanced Formative Assessment (TEFA) approach, using classroom response system technology, into their instruction. Through mixed-methods analysis of longitudinal data from PD transcripts, participant interviews and surveys, student surveys, and classroom videotape, we constructed case studies of individual participants' learning and change trajectories. Based on cross-case analysis of these case studies, we formulated and tested a "model for the co-evolution of teacher and pedagogy", which describes teacher pedagogical change in terms of three dialectically interacting narrative strands: a teacher's growth of new skills and perspectives, evolution of pedagogical aspirations and practices, and experiences with PD. The model integrates multiple existing perspectives on teacher change, such as the teacher knowledge, teacher reasoning, sociocultural, and way-of-being perspectives. Connecting the model to cultural-historical activity theory helps account for the social and community aspects of PD and teacher learning.

S10.11.2 Is Science Inquiry Professional Development Effective? A Critical Review of Empirical Research

Daniel K. Capps, Cornell University
Barbara Crawford, Cornell University

Educational theorists and researchers have advocated for the use of inquiry-based instruction in science classrooms. Inquiry-based instruction has the potential to enhance student understanding and engagement in science. However, most teachers are underprepared to teach science using this approach. In response, teacher professional development is commonly used to support teachers in enhancing their knowledge, changing teaching practice and improving student achievement. Unfortunately, little empirical evidence exists to demonstrate the effectiveness of teacher professional development in supporting teacher growth. A major challenge in science education today is to link teacher participation in professional development to enhanced teacher knowledge, changes in teaching practice and improved student achievement. We present a critical review of research of 14 inquiry- based professional development programs. Our review focuses on the reported outcomes of each program. Available data support our hypotheses that in-service programs which immerse teachers in authentic inquiry will more likely 1) enhance teacher knowledge, 2) prepare teachers to implement inquiry instruction and 3) lead to enhanced student understanding. Implications for future research on inquiry-based professional development programs are discussed.

S10.11.3 Sustaining Change: Are Booster Shots Needed?

Jane Butler Kahle, Miami University
Yue Li, Miami University
Kathryn Scantlebury, University of Delaware
Constance W Blasie, University of Pennsylvania

This study analyzes the efficacy of quality professional development to change teaching practices that enhance student learning; e.g., those advocated by the National Science Education Standards. Responses of chemistry teachers who participated in two different, multi-year, NSF-funded projects at an Ivy League institution and their students provided the data to analyze teaching change, sustained change, and student learning. The analyses indicate that teaching practices changed and that some of those changes were sustained for up to five years. In addition, mean scores of student achievement tests suggest that student learning is enhanced during the period of teacher professional development and for a limited time afterwards. The findings indicate that science educators need to be more proactive in providing follow-up opportunities for professional development projects and to encouraging policies at the state and national levels that will provide funding to support such efforts.

S10.11.4 Can Science/Math Teachers Gain Their Inquiry Teaching Competence from Inservice Teacher Education

Hsiao-Lin Tuan, National Changhua University of Education, Taiwan
Chien-Chung Tseng, National Changhua University of Education, Taiwan
Meichun Lydia Wen, National Changhua University of Education, Taiwan
Erh-Tsung Chin, National Changhua University of Education, Taiwan
Kuo-Hua Wang, National Changhua University of Education, Taiwan

The purpose of this study is to report 81 inservice science/math teachers' learning outcome from an in-service teacher education program addressed on inquiry teaching competency. Three-year science/math teacher education courses designed to enhance experienced science/math teachers' competencies in: math/science inquiry, inquiry teaching, and inquiry activity design were reported. Eighty one experienced science/math teachers with different years of enrollment in the program participated in the study. Questionnaire assessing teachers' inquiry teaching efficacy questionnaire (ITEQ) was implemented before and after each year of the courses. In addition, 45 teachers were selected from the 81 participants to conduct structured interviews. Finding indicated that our inservice teacher education program can significantly enhance science/math teachers' inquiry teaching competency, in terms of their inquiry competency (IC), understanding of inquiry (UI), teaching inquiry competency (TIC), guiding and assessing inquiry (GAI), expectation of inquiry teaching outcome (EITO). Each year enrollment of the science/math teachers have gained significantly on the above categories. In addition, science teachers gain significantly higher score than math teachers on their inquiry teaching competency. Interview data supported with the above findings, teachers felt they gain deeper understanding of inquiry and inquiry teaching after enrolled in the program.

S10.12 Strand 10—SC-Paper Set: Probing Student Understanding and Reasoning

S10.12.1 Ontology-Informed Diagnostic Assessment of Middle and Secondary Students' Understanding of the Particulate Nature of Matter

Ajda Kahveci, Marmara University
Dilek Ozalp, Marmara University

The purpose of the current study was to evaluate student understanding on the topic particulate nature of matter through assessment based on the relationship between ontology and misconceptions. An instrument of 25 distractor-driven, multiple-choice diagnostic items, 15 of which were two-tier, was constructed. The instrument was pilot tested with 178 students and administered in the spring semester of 2007-2008. Cross-sectional survey methodology was employed for assessment across Grades 6-11. Data were collected from a randomly selected sample of 696 students attending primary and secondary schools in a metropolitan area. The overall trend emerged to be improved student knowledge with increasing grade level. Unexpectedly, in some cases a higher percentage of high school than middle school students appeared to hold misconceptions. The students in the sample most often tended to attribute the properties of macroscopic matter to its microscopic particles and had most difficulty in explaining dissolving at the particle level, confirming previous national and international findings. An understanding of misconceptions from an ontology perspective may further assist educators to enhance a conceptual change. Distractor-driven, two-tier multiple-choice items are envisioned to aid stakeholders in curriculum development and implementation by illuminating student conceptions and ways of thinking in depth.

S10.12.2 Development and Pilot Testing of Ontology-Informed Distractor-Driven Diagnostic Instrument on the Particulate Nature of Matter

Dilek Ozalp, Marmara University
Ajda Kahveci, Marmara University

Student conceptions related with matter and the particulate nature of matter, are vital for advanced understanding in chemistry, and have been a research area of increasing attention. Lacking in the literature are studies addressing chemical misconceptions from an ontological point of view. The purpose of the current study was to develop an instrument assessing student understanding on the topic by utilizing ontological categories as theoretical lens. We particularly focused on: 1) portraying the ontological basis of related misconceptions and incorporating those in the distractors, 2) the way student feedback during pilot testing aided item development, 3) student thinking as revealed through their provided feedback. Aligned with content in the middle school curricula, an assessment instrument of 25 distractor-driven, multiple-choice items, 15 of which were two-tier, was constructed. Subsequent to content validity work, to utilize student feedback for the improvement of the items and the validity of the inferences, we pilot tested our instrument in the second semester of 2007-2008 with 178 students attending a middle school and a private tutoring center in a metropolitan area. In this paper we discuss the development process and exemplify the revisions made according to student feedback and results from the pilot testing.

S10.12.3 Design Research on the Assessment of Geological Observation: The Components of Perception, Explanation, and Gestures

John Y. Baek, Oregon State University

This study investigated the assessment of geological observation through the development and testing of performance tasks, an approach called design research. Design research study led to a new learning environment, both materially (GO Inquire) and culturally (geoscience in the elementary classroom), that in turn required conceptual framework for assessment (perception, explanation, and gestures). To observe the environment like a geologist is a deceptively complex process. The teaching and learning of geological observation is complicated by the fact that many geological processes are unobservable. The GO Inquire prototype is a database-driven web application that scaffolds elementary students to perform the act of geological observation in a manner consistent with a geomorphologist. Given the performance of geological observation, how should the performance of geological observation be assessed? The three components, perception, explanation, and gestures, that emerged in understanding the assessment of geological observation will be presented. Findings from the investigation may assist teachers, not expert in geoscience, to implement and assess authentic geological observation in their instruction. The knowledge generated by this study provides further understanding about teaching and learning geological observation.

S10.12.4 Using Content-Aligned Assessment to Probe Middle School Students' Understanding of Ideas about Energy

Cari F. Herrmann-Abell, Project 2061 / AAAS
George E. DeBoer, Project 2061 / AAAS

We report the results of a pilot test of assessment items aligned to the middle school topic of energy administered to 1728 sixth, seventh, and eighth grade students from 11 widely varying school districts across the country in the spring of 2008. This paper presents assessment items aligned to the key ideas of motion energy, thermal energy, gravitational energy, and elastic energy and describes how we use information gathered from the students to gain insight into students' thinking as well as insights about the quality of the items themselves. This work is part of a larger project funded by the National Science Foundation to develop items that are precisely aligned with national content standards. Each item is developed using a procedure designed to evaluate an item's match to important science ideas and its overall effectiveness as an accurate measure of what students do and do not know about those ideas. During item development, pilot testing is used to obtain feedback from students about the items. Then scientists and science education experts review the items using a set of criteria to ensure content alignment and construct validity. After revisions are made based on the reviews, the items are field tested on a large national sample to determine the psychometric properties of the items and clusters of items.

S10.13 Strand 11—SC-Paper Set: Revisiting Gender and Race in Science Education

S10.13.1 Awakening a Dialog: Examining Gender and Race in NOS Studies from 1967 to 2008

Leon Walls, Purdue University
Lynn A. Bryan, Purdue University

Researchers have shown that the explicit teaching of a core group of generally agreed upon NOS tenets could greatly influence K-12 science literacy. Improved science learning in K-12 classrooms, effective decision making, competent usage of science, and increased recruitment into science related careers are but a few of the potential outcomes for the scientifically literate individual. As K-12 classroom become increasingly diverse, the science education community needs to seize opportunities to attend to the rhetoric of reform—i.e., to enhance scientific literacy for all students— and to awaken dialog that confronts implicit assumptions, beliefs, and practices in research that may serve to undermine science education for student who are from racial/ethnically diverse backgrounds. To this end, this study examined three top peer-reviewed science journals with respect to participant race and gender reported in NOS studies from 1967 to 2008. Findings show that 71% of studies reported gender, with female participants well represented in the studies. However only 22% reported race; and of those studies that reported race, populations of color were overwhelmingly underrepresented. We explore the implications of dysconscious racism (Ladson-Billings, 1994), and raise the question for discussion, "Who needs to be represented in science education research?"

S10.13.2 Quantifying the Gender Gap in Science Interests

Ayelet Baram-Tsabari, Technion, Israel
Anat Yarden, Weizmann Institute of Science, Israel

Nearly 5,000 self-generated science-related K-12 students' questions, classified into seven science subjects, were used to quantitatively measure the change in gender gap in science interests with age. The difference between boys' and girls' science interests did not exist during early childhood, but increased over 20-fold as they grew older. Furthermore, the gap widened in a stereotypical manner, with girls being increasingly interested in biology and boys more interested in physics and technology. These differences in science interests should be considered when deciding on the content and context of the science curriculum, which should be relevant and attractive to both genders.

S10.13.3 Exploring How Urban African-American Girls Position Themselves in Science Learning

Gayle Buck, Indiana University
Kristin Cook, Indiana University
Cassie Quigley, Indiana University
Jennifer Eastwood, Indiana University

The purpose of this study was to increase the science education community's understanding of how urban African American girls from low SES communities position themselves in science learning. As the previous studies completed in this area focused on small number of individuals, we were seeking to expand that work by exploring the possibility of identifying groupings of personal orientations toward science. This mixed-method sequential explanatory study was guided by research hypotheses and questions. By linking the quantitative and qualitative data, we were able to expand our understanding of the similarities and differences within this population of students. The descriptive statistics showed four personal orientations toward science: high desire/value and high confidence/anti-anxiety, low desire/value and high confidence/anti-anxiety, and low desire/value and low confidence/anti-anxiety. The qualitative data provided a rich description of the girls' voices about science including actual descriptions of science, importance, experiences and success in school science. By combining these data sets, insights emerged into this seemingly homogeneous group to demonstrate the vast differences and similarities in these girls' profiles and understand how these girls orient themselves as learners of science.

S10.14 Strand 11—Symposium: Science, Science Education and the War on Terror

Wendy M. Frazier, George Mason University
Andy Johnson, Black Hills State University
Geeta Verma, Georgia State University

This symposium explores different interactions between science education, both formal and informal, and the war on terror. Participants represent both positive and critical views of the war. One panel member finds in the war new possibilities for making science relevant by connecting children with intelligence agencies and practices drawing on a mixed methods study of a 5th graders. Another, drawing on empirical work with elementary students, finds that the war on terror problematizes multiculturalism and equity in science education because such discourses overlook emergent identities and experiences wrought by global, neoliberal economic practices and emerging forms of state and civil violence. Building on that, a third member of the panel, mixing philosophy, curriculum document analysis, and personal experience, expands on how the choices science teachers make are active in producing politically disengaged and uncritical citizens. Finally, the fourth member of the symposium, explores the media coverage of the 2001 anthrax attacks as a curriculum in the nature of science, a curriculum that unintentionally produced a simultaneously panicked and powerless public. The panelists come together on the need to make science education more meaningful and especially relevant by being conscious of social, political, and scientific changes keyed to this historic moment.

S10.15 Strand 13—Symposium: Grand Challenge and Great Opportunity: Fully Taking the Practice Turn in Science Education with Respect to Scientific Work

Gregory J. Kelly, Penn State University
Wendy Newstetter, Georgia Institute of Technology
Leah A. Bricker, Loyola University Chicago

In this symposium, we wish to engage the science education community with what it means to take "the practice turn" in science education. Making the sociocultural practices associated with scientific work a guiding influence in science education exemplifies this year's conference theme of Grand Challenges and Great Opportunities in Science Education. The presenters in this symposium argue that science educators must embrace the challenge of truly taking the multifaceted and nuanced practices of scientific work into account when studying and designing learning environments related to P-16 science education. Presenters will present a theoretical rationale for fully taking the practice turn, present studies of scientific work in university research labs, relate these perspectives to the science learning of children and communities, identify implications of the "practice turn" for the science education enterprise, and discuss the dilemmas of connecting scientific practice to science education.

S10.16 Strand 14—SC-Paper Set: The Impact of Socio-Cultural Factors on Environmental Education

S10.16.1 The Impact of Socio-environmental Projects of Jewish and Arab Youth in Israel

Iris Alkaher, Technion - Israel Institute of Technology
Tali Revital Tal, Technion - Israel Institute of Technology

To follow-up two multicultural socio-environmental projects of Jewish and Arab youth in northern Israel (Projects A and B), we investigated the projects' influence on participants environmental knowledge, awareness and behavioral intentions. Moreover, we studied participants' views toward these aspects concerning their neighboring community. The participants were junior high school students from two neighboring Arab and Jewish communities. Data collection included open-ended questionnaires which were inductively analyzed according to emerging categories. According to students' responses we found ethnic differences with regard to students' learning about the socio-ecological system, and their knowledge about the other community, and understanding the mediation process that took place to resolve a sensitive regional socio-environmental conflict (Project A). The impact of the projects differed among the Jewish students and the Arab students concerning environmental knowledge, awareness and behavior. This study raises questions concerning the appropriate ways to implement environmental programs that bring together culturally and environmentally diverse groups. Such projects are worthwhile in that they provide opportunities for meaningful meetings between Jewish and Arab youth in Israel and collaboration on the basis of common motives.

S10.16.2 Science Education for the Environment - Cross-National Evidence Relating Science Performance to Environmental Attitudes

Jelle Boeve-de Pauw, University of Antwerp
Peter Van Petegem, University of Antwerp

A multilevel analysis is performed on the most recent PISA data concerning environmental attitudes and scientific performance. Based on these data, the authors show that girls are slightly more pro-environmentally orientated than boys and that youths from advantaged socio-economic and cultural backgrounds are more likely to display attitudes that contribute to a sustainable environment. The results also show a significant and substantial positive effect of scientific performance on environmental attitudes. This effect is present in all countries participating in PISA 2006. Differences between countries are linked to a.o. country-level curriculum choices. Furthermore, results indicate that youths' environmental attitudes are substantially and positively influenced by living in countries with rich natural environments (as measured by the National Biodiversity Index). The influence of the Human Development Index, and national indices of exposure to environmental problems on environmental attitudes are assessed in the light of the Nature Extraction Theory and the Environmental Deprivation Theory. Implications for science teaching and environmental education will be discussed.

S10.16.3 Science Learning in Confronting Environmental Lead Contamination

Jill C McNew, Washington University in St. Louis

Although global issues of environmental concern (e.g. global climate change) have garnered a great deal of public attention of late, environmental threats effecting localities have been a central focus of local community activism for some time. This case study builds on backgrounds from diverse disciplines to examine advocacy around the local environmental challenge of industrial lead contamination in the town of Herculaneum as an important context for the learning of science. Science learning here is viewed in terms of the ways that various participants acquire and leverage different forms of science knowledge to shape the ways that lead contamination is understood and managed in this community. It is argued that widespread issues of local environmental concern provide important and relevant contexts for a form of science learning that is closely connected to activism, democratic citizenship, and personal efficacy.

S10.16.4 An Investigation of Gender Effect on University Students' Environmental Reasoning Patterns toward Environmental Moral Dilemmas

Busra Tuncay, Giresun University
Ozgul Yilmaz Tuzun, Middle East Technical University
Cihan Gulin Cihangir, Giresun University

This study aims to find out whether there would be differences in the participants' reasoning toward the given environmental moral dilemmas, which would be an indicator of a possible "gender gap" in people's environmental concerns. A sample of 85 university undergraduates (46 female and 39 male) with a mean age of 22.83 years participated in the study. In-depth analyses were conducted on the responses given by the participants to examine their environmental moral reasoning patterns and thus look for a possible gender difference in their concerns about the consequences of the environmentally damaging actions presented in the given dilemmas. The results of the study demonstrated no significant difference between males and females in concern about the consequences of the presented environmental moral dilemmas and indicated that gender is just a weak predictor of environmental concern among university students.

S10.17 Strand 15—Symposium: Challenges and Opportunities for Science Education in Arab States

Zoubeida R. Dagher, University of Delaware
Ghada Gholam, UNESCO Cairo Office
Fouad Abd-El-Khalick, University of Illinois at Urbana-Champaign
Saouma BouJaoude, American University of Beirut
Nasser Mansour, University of Exeter

Apart from a number of UNESCO reports and relatively few published journal articles in international journals, little is known about the state of science education in Arab states outside their geographical boundaries. This symposium aims to shed light on science education issues in various countries within the Arab region which is currently undergoing major educational developments that seldom get discussed in international circles. The symposium presenters will engage the audience with a discussion on the current challenges and opportunities for science education research and development in the Arab region with regards to five topics: 1) nature of science features in curriculum standards/documents, 2) professional development models, 3) research trends, 4) role of non-governmental organizations in supporting reforms, and 5) science and religion issues.

S11.1 External Policy Sponsored Session—Symposium: Part II—Math Science Partnerships (MSPs): Rising to the Grand Challenges of Bringing Contemporary Science to K-12 Teachers and Students and Providing Evidence of Impact

Amy Edmondson, Centralia Elementary School District (California)
Terry L. McCollum, Miami University (Ohio)
George Nelson, Western Washington University
Carolyn Landel, Western Washington University
Bill Schmidt, Michigan State University

In this session, participants who attended the symposium, "Math Science Partnerships (MSPs): Rising to the grand challenges of bringing contemporary science to K-12 teachers and students and providing evidence of impact" will have the opportunity to interact in Q&A groups with four MSP directors as well as representatives of the U.S. Department of Education and the National Science Foundation.

S11.2 Research Committee Sponsored Session—Technology Symposium: The Impact of Video Analysis on the Development of Professional Vision in Preservice and Practicing Teachers

Scott McDonald, Penn State University
Brett Criswell, Penn State University
Oliver Dreon, Millersville University
Steve Kerlin, Penn State University
Mark Merrit, Penn State University
Chris Ruggerio, Penn State University
Scott DeLone, Penn State University
Cecilia Tang, Penn State University

This session focuses on the use of video analysis as a way to develop rich contextual understandings of classroom inquiry science pedagogy for both preservice and practicing teachers. Participants will engage in analysis and discussion of video of classroom teaching based on an initial framework using a video analysis software program (Studiocode). Discussions will follow of the development of the framework and the research underlying the framework and the larger project, the Invisible College for Inquiry Science Study (ICISS). The focus of the session will be on the process and impact of video analysis and not the presentation of existing research findings.

S11.3 Strand 1—SC-Paper Set: Development of Concept in the Biological and Physical Sciences

S11.3.1 Promoting Middle School Students' Understanding and Integration of Multiple Conceptual Models in Genetics

Hava B. Freidenreich, Rutgers University
Ravit Golan Duncan, Rutgers University

Genetics is the cornerstone of modern biology and understanding genetics is a critical aspect of scientific literacy. Research has shown, however, that many high school graduates lack fundamental understandings in genetics necessary to make informed decisions about issues in this domain or to participate in public debates over emerging technologies in modern genetics. Currently, much of genetics instruction occurs at the high school level. However, recent policy reports advocate a learning progressions approach to science instruction, in which important concepts are introduced early on and students develop successively more sophisticated understandings of these concepts throughout their schooling. Designing a learning progression for genetics is challenging given the limited research about genetics learning at the middle school level. In this paper, we discuss a research study aimed at empirically testing a learning progression for genetics that spans middle and high school. As part of our research, we designed an eight-week model-based inquiry unit implemented in a 7th grade science classroom and a combined 6th-8th grade science classroom. We describe our instructional design and report results based on analysis of pre and post written assessments and written artifacts of the unit.

S11.3.2 Linear Estimation: Contexts and Spatial Abilities

Jennifer H. Forrester, NC State University
M. Gail Jones, NC State University
Amy R. Taylor, University of North Carolina
Grant E. Gardner, NC State University

This study examined students' ability to estimate linear measurements. Through a series of different tasks students' accuracy in estimation was assessed for horizontal versus vertical lengths, raised and flat lines, embedded and non-embedded lines, and 3D and 2D figures. Participants included a sample of 45 middle school students. Results showed that students tended to underestimate vertical and horizontal distances and 2D objects while overestimating raised lines and 3D objects. Spatial ability was significantly correlated with students' ability to estimate horizontal and vertical oriented objects.

S11.3.3 Students' Conceptions of the Human Cardiovascular System: Levels of Understanding and Implications for Learning

Philipp Schmiemann, University of Duisburg-Essen, Germany
Martin Linsner, University of Duisburg-Essen, Germany
Angela Sandmann, University of Duisburg-Essen, Germany

One of the most difficult challenges for teachers is the individual advancement of their pupils. To foster students' development in understanding biological concepts it is necessary to have an accurate knowledge about their actual conceptions of certain biological ideas. The focus of the study is the understanding of the human cardiovascular system, an important topic in biology teaching. Taking into account typical misconceptions, multiple choice test items have been developed to assess the hypothetical levels of understanding. About 3000 students of different class levels took part in the achievement test. A one parameter Rasch model was used for parameter estimation because of a multi matrix sampling design. In item fit statistics there is no significant deviation from the distribution, so all items fit the model. Hence there was no need to reject any item. Three levels of understanding have been identified. Furthermore there is a crucial influence of terminology on item difficulty. The results give strong indications how to foster students' understanding of the human cardiovascular system in future.

S11.3.4 A Ten-Year Study Following Students' Ideas about Situations in Which Transformations of Matter Occur

Lena Löfgren, Kristianstad University College, Sweden

This paper presents results from a ten-year longitudinal study. The study's aim is to learn more about how students actually make meaning and come to understand transformations of matter. The theoretical framework builds upon social constructivist perspectives. In the study (1997-2006) 23 students all born in 1990 are followed. Interviews allowing the students to explain the transformation of matter in fading leaves left lying on the ground, burning candles, and a glass of water with a lid on have been performed. The students have altogether been interviewed 14 times. In 5 interviews the students have listened to an earlier interview and have had the possibility to comment earlier statements and reflect upon their own learning. Most students make progress in describing and explaining the situations in the first years of the study. Then there is a vast spread in the students' capability to connect the science taught in school with the processes; decay, burning, evaporation and condensation taking place in the situations. There seems to be a connection between the above mentioned capability and what is said about learning. The implications for science education research, compulsory school science curricula, and school science education out of these findings are discussed.

S11.4 Strand 2—SC-Paper Set: Science Achievement and Inquiry Based Learning

S11.4.1 Windows into High-Achieving Science Classrooms

Joseph A. Taylor, BSCS Center for Research and Evaluation
Molly A.M. Stuhlsatz, BSCS Center for Research and Evaluation
Rodger W. Bybee, PISA

This study was a secondary analysis of 2006 science assessment data from the Organisation for Economic Co-operation and Development's (OECD) Programme for International Student Assessment (PISA). Correlations between frequency of classroom learning experiences (student reported) and science literacy scores were explored across all participating countries. The learning experiences with statistically significant positive correlations with science literacy were those where: students were asked to draw conclusions from an experiment they had conducted, students were given opportunities to explain their ideas, and where the teacher explained how a science idea can be applied to a number of different phenomena. As an implication for teaching and learning, researchers suggested use of a learning cycle of explore, explain, and apply (in that order).

S11.4.2 Testing a Premise of Inquiry-Based Science Instruction: Exploring Small Group Processes and Its Link to Student Learning

Maria Araceli Ruiz-Primo, Univeristy of Colorado Denver
Maria Figueroa, Stanford University

The work in small groups has been considered a critical characteristic of scientific inquiry instruction (National Research Council, 2001). It has been assumed that small-group interactions provide students with opportunities to construct knowledge together by learning from

each other, to become more active in the learning process, to learn communication skills, and to gain ownership of their own learning. In this study we provide evidence around some of these arguments. More specifically, we explored two dimensions of small groups, social and cognitive, in three phases of the group process: setting, conducting, and closing the task at hand. The study was guided by the following questions: What are the social and cognitive profiles of small groups when approaching a science investigation? What is the role of the teacher in the social and cognitive functions of the small group? Is there a link between the social and cognitive profiles of the small group in which students participated and the students' learning? To respond to these questions we identify, describe, and categorize events occurring among members of small groups conducting a science investigation and link these events to students' performance in diverse assessments administered at the end of the science unit.

S11.4.3 The Influence of Motivation and Epistemological Beliefs on Students' Achievement

Aylin Cam, Middle East Technical University

Epistemological beliefs may be defined as personal and implicit beliefs' systems or students' assumptions about nature of knowledge and learning (Schommer, 1990). Brophy (1988) states that motivation to learn is "a student's tendency to find academic activities meaningful and worthwhile and to try to derive the intended academic benefits from them" (pp. 205– 206). Thus, to promote students' achievement, the interaction between students' epistemological beliefs and motivation should be evaluated. The purpose of this study is to find out the relationship between ninth and tenth grade chemistry students' scientific epistemological beliefs and motivation considering multidimensionality of both epistemological belief and motivation instrument. Students' motivation to learn and epistemological beliefs in chemistry and the contribution of students' motivation and their epistemological beliefs in the prediction of students' achievement in chemistry were examined. The sample of this study consisted of 242 (107 girls, 135 boys) students both from first and second year in three different High Schools. Science Motivation Questionnaire (SMQ) and Epistemological Beliefs Questionnaire (EBQ) were administered. Correlation and regression analyses were conducted. The results indicated that students' epistemological beliefs and their motivation are negatively related to each other. Students believing knowledge as certain appeared to get lower grades in chemistry.

S11.4.4 Cycles of Exploration, Reflection, and Telling in Model-Based Learning of Genetics

Beaumie Kim, Nanyang Technological University, Singapore
Suneeta A. Pathak, National Institute of Education, Singapore
Michael J. Jacobson, The University of Sydney, Australia
Baohui Zhang, Nanyang Technological University, Singapore
Feng Deng, Nanyang Technological University, Singapore

This paper describes how Biologica™ (Concord Consortium, 2000), a model-based learning environment, was used in a study of learning genetics in a Singapore school. The decision to use an innovative technology-based system in Singapore required that the research team take into consideration special conditions in this country. Model-based reasoning with BioLogica was integrated into the regular biology classes of O-level students at a local school for a module on genetics. Adopting a "time-for-talking time-for-telling" paradigm (Schwartz & Bransford, 1998), the research team worked out two different pedagogical sequences that involved mixing BioLogica as part of a learner centered ("exploration and reflection") approach with a teacher led ("telling") approach as the students learned about genetics. One treatment group used the learner centered BioLogica approach first for all topics prior to teacher led instruction, whereas the second condition went through a cycle of these approaches for each topic. Preliminary findings indicate that the second approach was more effective in conceptual understanding. We are currently analyzing cases from the second approach, which might support our hypothesis that the shift in mental models of evolution is associated with a deeper understanding of genetics. We will report our further analysis in the conference paper.

S11.5 Strand 2—Related Paper Set: Using Cogenerative Dialogue to Expand the Participation and Achievement of Urban Youth in and Out of School

S11.5.1 Using Cogenerative Dialogues to Improve High School Science and to Expand the Potential of Youths' Social Lives

Kenneth G. Tobin, CUNY
Reynaldo Llena, CUNY
Rowhea Elmesky, Washington University

For more than a decade research in urban high schools in the United States has investigated cogenerative dialogues in relation to the quality of science teaching and learning. The goals of using cogenerative dialogues are oriented towards improving the quality of learning environments, essentially transforming classroom environments from dysfunctional to highly productive. This paper examines a range of outcomes associated with using cogenerative dialogue in a high school in the Bronx of New York City, over a period of four years. Macro-, meso-, and micro-analyses of a variety of data include semester grades, achievement on the New York State Regents examinations, long term ethnography of the teaching and learning of physics, chemistry and living environment, conversation analyses of videotapes of four years of science lessons and cogenerative dialogues. A central focus is the investigation of students' lives out of school concerning the potential for participation in cogenerative dialogues to afford students producing culture that was applicable generally to their lifeworlds. We study the transition from school to higher education, work, and life out of school in addition to transitions from one school year to the next, and one science subject to another.

S11.5.2 Exploring Multiple Outcomes: Using Cogenerative Dialogues and Coteaching in a Middle School Science Classroom

Nicole K. Grimes, CUNY

Coteaching and cogenerative dialogues have become widely used methodologies in science education in the last twenty years. Following up on the work of a few recent New York City science educators, I decided build upon their groundbreaking work that all attest to the significant benefits of integrating such methodologies into their own science classrooms. As a result of coplanning and participation in weekly cogenerative dialogues with three other tenth grade student-researchers, we cotaught several lessons across various science disciplines in my sixth grade classrooms for one academic year. As a result, there have been a plethora of key outcomes as a result of the work done with my student-researchers with far-reaching implications for improving the teaching of science. Some of these transformations observed include science identity shifts, classroom behavior changes and improved performance on formal science assessments. This is a central component of the research authenticity criteria as described by Lincoln & Guba (1989). In line with their described criteria, this paper will take a multifaceted look at each group of individuals involved in this year-long research, including myself, and consequently explore the numerous transformations that occurred for the members both in and out of the science classroom field.

S11.5.3 The Role of Face-to-Face Interactions in Developing Scientific Fluency

Ashraf Shady, Queens College, CUNY

As an immigrant science teacher I explored ways by which I could enhance the scientific fluency of my minority students, which is interconnected to their emotional state. In this study I investigated ways by which I could support the production of positively valenced emotional energy, and reduce instances where transactions would give rise to negative emotional energy. Conversation analysis together with a description of facial and other bodily displays represented means by which I could draw conclusions on the production, and reproduction of successful social interactions. Implications are presented for the teaching and learning of science in urban middle schools, characterized by high proportions of ethnic minorities from conditions of abject poverty.

S11.5.4 Improving Science Achievement Using Cogenerative Dialogue and Coteaching

Reynaldo Llena, CUNY
Kenneth G. Tobin, CUNY

This study examined how well cogenerative dialogue and coteaching help in evolving a classroom culture that positively affords students' science achievement as measured by content-based and state standardized tests. Course grades and test scores in chemistry egents examination of students (n=64) from a small high school in the Bronx, New York were investigated. A significant difference was found in course grades and regents test scores between students who actively participated in cogenerative dialogue and coteaching and those who were non-participants. Students active in cogenerative dialogues have higher course grades (M=82; SD=7.7) than the non-participants (M=74; SD=4.6). Analysis of students' test scores in Chemistry Regents examination also revealed a similar trend. An ethnographic study of students who emerged as student leaders in cogenerative dialogues and coteaching is presented in this work. The experience of students in adopting the structures, rules, roles, and focus of cogenerative dialogues is discussed.

S11.6 Strand 4—SC-Paper Set: Effects of Curriculum Initiatives in Secondary Schools

S11.6.1 The Effect of a Laboratory-Based Genetics Program on High School Student Learning: A Comparative Analysis

Victoria L. May, Washington University
Patricia Simmons, University of Missouri

Abstract This proposal reports on research conducted to determine the effectiveness of an inquiry-based, student-centered genetics curriculum implemented by 11 teachers over two academic years. The study employed a quasi-experimental methodology comparing the performance of students on an assessment before their teachers were provided professional development on the new curriculum and after they implemented it in their high school classrooms. The students in the control group were taught by direct instruction with the primary resource, a textbook. The students in the treatment group were taught through lab investigations illustrating the content and methods of current genetics. Several statistical analyses indicated significant knowledge and attitude gains by students of participating teachers after they taught the new curriculum compared to students of the same teachers before, with a 38% higher performance on the questions requiring higher order thinking skills. An analysis of domain specific questions showed significant increases in students' breadth of concepts relevant to understanding the importance of genetics in the 21st century.

S11.6.2 Promoting Students' Conceptual Understanding on Plants' Responses Using Fighting Plant Learning Module (FPLM)

Nantawan Nantawanit, Mahidol University, Thailand
Pintip Ruenwongsa, Mahidol University, Thailand
Bhinyo Panigpan, Mahidol University, Thailand

Plant science is one of the learning contents equally important to animal science. However, most of students generally think animals are more interesting than plants, having alternative conceptions that plants are inferior to animals and are passive organisms in which cannot be responsive to anything. Naturally, plants can respond to many stimuli, particularly biological stimuli such as microorganisms and insect herbivores, in many interesting ways. The purpose of this study was to develop a learning module, Fighting Plant Learning Module (FPLM), for promoting the conceptual understanding on plants' responses to biological stimuli. The study also investigated students' perceptions to the FPLM learning environment in which constructivism was used as the theoretical based for the teaching and learning processes. A total of 31 Thai science-major students from Grade 12 participated in this study. Multiple data-gathering techniques were employed; conceptual testing, concept mapping, the Constructivist Learning Environment Survey (CLES) and interview. The study demonstrates that the students developed conceptual understanding on plants' responses to biological stimuli. In addition, students' interest on learning with other contexts of plant science was motivated. They seemed to have a positive learning outcome that was based on students' preference and perception of classroom based constructivist learning environment. An involvement of the teacher with appropriate teaching method also enhanced learning process.

S11.6.3 A Study of Three Science Teachers' Implementation of Inquiry-Based Curriculum

Jing Chen, Michigan State University
David Fortus, Weizmann Institute of Science

We report our findings from three middle school science teachers' teaching practices when they implement an inquiry-based 7th grade physics unit. We focused on their enactment of hands-on activities and compared their teaching behaviors when conducting the same activities in the unit. We found teaching inquiry-based curricula does not guarantee REAL inquiry-based teaching. Though all teachers were provided the same detailed teacher guide, only one teacher taught science as inquiry. She engaged students in scientifically oriented questions, helped them to formulate explanations from evidence and connect explanations to scientific knowledge. The other two teachers are still used to the traditional ways of telling students the "right answer" rather than help them to construct knowledge by experiencing and investigating the material world. In their class, the activities were often conducted as distant from scientific knowledge or practice and the assessments of students' thinking are often ignored. We also found teachers who work in less advantaged position (e.g. urban school, with unruly students) met difficulties to adjust inquiry teaching into their own contexts. It's important to give them further support besides curriculum materials to achieve real inquiry teaching.

S11.6.4 Using Video Games in Science Instruction: Pedagogical and Design Challenges

Kamini Jaipal, Brock University
Candace Figg, Brock University

This study explored the implementation of the video game "Nano Legends" by four grade 8 science teachers in Ontario, Canada. In this paper, we document the experiences of how one teacher integrated the video-game in 2 grade 8 classes. A qualitative case study design was used. Data sources included individual interviews with the teacher, video-tapes of classroom instruction, lesson observations, teacher and student artefacts and interviews with students. Findings indicate two emergent challenges: pedagogical factors impacting the effective integration of video-games in classroom practice and video game design factors impacting student learning. Implications for appropriate and successful teacher use of video- games in actual classroom practice and recommendations for video game design are discussed.

S11.7 Strand 5—Related Paper Set: Studying Conceptual Understanding in Physics

S11.7.1 Analogical Scaffolding: The Use of Analogy and Representation to Promote and Understand Conceptual Learning in Physics

Noah D. Finkelstein, University of Colorado
Noah S. Podolefsky, University of Colorado

This paper describes a model of analogy, analogical scaffolding, which explains present and prior results of student learning with analogies. We build on prior models of representation, blending, and layering of ideas. Empirical studies, based on this model, demonstrate the model's utility and the vital intertwining of representation, analogy, and conceptual learning in physics. We show that representations couple to students' existing prior knowledge and also lead to the dynamic formation of new knowledge. Students presented with abstract, concrete, or blended (both abstract and concrete) representations demonstrated markedly different conceptual learning about electromagnetic (EM) waves. Using analogies to scaffold understanding of EM waves, students in the blend group were more likely to reason productively about EM waves than students in the abstract group by as much as a factor of three (73% vs. 24% correct, $p=0.002$). Using the analogical scaffolding model we examine when and why students succeed and fail to use analogies and interpret representations appropriately. Extending this model's explanatory power, we propose ways the model can be applied to design curriculum directed at teaching abstract ideas in physics using multiple, layered analogies.

S11.7.2 Using Concrete and Abstract Contexts to Study Conceptual Understanding

Andrew F. Heckler, The Ohio State University

Many studies have shown that student performance can vary dramatically with context. The question now becomes, precisely which factors are responsible for the variation in performance? Understanding in detail the factors that influence student answering on questions is critical to any fundamental advancement of teaching, learning, and assessment. In a series of experiments, we examine a particular dimension of contextual variation, namely concrete vs. abstract. We examine student performance on physics questions posed in either abstract or concrete storylines. Results indicate that there are important trade-offs between concrete and abstract representations. First we find that students often answer concrete problems correctly more often, and this is most likely due to the use of common, intuitive knowledge to help solve the problem. However, we find evidence indicating that conceptual understanding is tightly bound to concrete contexts, and in situations in which misconceptions are common, the concreteness of a representation can also inhibit the use of appropriate concepts. Thus these experiments highlight the inherent benefit and detriment of prior knowledge when answering questions in concrete contexts.

S11.7.3 Evolving Student Knowledge in a Physics Classroom

Eleanor C. Sayre, The Ohio State University
Andrew F. Heckler, The Ohio State University

A common method for assessing student learning is pre- and post-tests. In the physics education research community, these assessments are often multiple-choice conceptual surveys. In this study, we collect student test data a number of times throughout a course, allowing for the measurement of the changes of student knowledge with a time resolution on the order of a few days. The data cover the first two quarters (mechanics, E&M) of a calculus-based introductory physics sequence populated primarily by first- and second-year engineering majors. To avoid the possibility of test-retest effects, separate and quasi-random subpopulations of students are evaluated every week of the quarter on a variety of tasks. Unsurprisingly for a traditional introductory course, there is little change on many conceptual questions. However, the data suggest that some student ideas peak and decay rapidly during a quarter, a pattern consistent with memory research yet unmeasurable by pre-/post-testing.

S11.7.4 The Role of Modeling Instruction in Establishing Supportive Learning Environments for Traditionally Underrepresented Students

Eric Brewe, Florida International University
Laird Kramer, Florida International University
George OBrien, Florida International University
Vashti Sawtelle, Florida International University

In this paper we describe Modeling Instruction, a physics reform pedagogy as the central element in creating a supportive learning environment for traditionally underrepresented student in physics. Conceptual learning as measured by the Force Concept Inventory (FCI) provides one indicator of the learning environment. We report FCI scores for students in Modeling Instruction and compare them with traditionally taught students. Modeling Instruction students outperform traditionally taught students on post instruction FCI (64.9% vs. 48.3%, $p<0.001$). FCI scores are further disaggregated by ethnicity and by gender and contrasted with measured Drop-Fail-Withdraw rates for introductory physics. Together these measures indicate that we have established a supportive learning environment for traditionally underrepresented students, which holds promise for increasing participation in physics by said students.

S11.8 Strand 6—Strand Invited Symposium: News Media Impacts on Public Understanding of Science

Martin Storksdieck, Institute for Learning Innovation
Eliene Augenbraun, ScienCentral, Inc.
John Falk, Oregon State University
John Fraser, Institute for Learning Innovation
Anthony Kola-Olusanya, University of Toronto
Jon Miller, Michigan State University
Patricia Moy, University of Washington
Bachir Raissouni, Alakhawayn University, Morocco

Various studies indicate that mass media, particularly news media, play an important part in informal learning, especially with regard to science and the environment. However, few have attempted to determine the direct influence of the news media on learning about science topics and issues. Here, we will explore science learning from the news media by examining forces that shape how science stories are reported; how media sets the public agenda and frames science issues; factors that influence what an individual hears and sees and ultimately learns; ways to conceptualize and measure the public's understanding of science and environmental issues; and related strategies to assess informal learning from news media. This symposium brings together a panel of researchers and practitioners experienced in examining media impacts. After a brief overview and introduction, panelists and audience members will participate in a lively discussion on how news media impacts public understanding of science, how best to assess this impact, and where future research efforts should be focused.

S11.9 Strand 7—SC-Paper Set: Preservice Teacher Education and Physics

S11.9.1 Physics Student Teacher's Professional Knowledge und Professional Action Competence

Josef Riese, University of Paderborn, Germany
Peter Reinhold, University of Paderborn, Germany

In recent years, disappointing results of large scale assessments like PISA have led to a rising interest in what are important aspects of professional action competence of (physics-) teachers and how they develop. Against this background, there is a lack of empirical research findings particularly with regard to the university phase of teacher education. Beside the efficacy of pre-service teacher education in general, the structure of physics teachers' professional action competence and the interaction of its aspects are of specific interest (Abell, 2007). Our study focuses on this by developing a model of professional action competence of pre-service physics teachers referring to Shulmans (1986) model of professional knowledge widened by dint of beliefs and personality factors. In a second step the model is applied to generate an instrument in order to measure different aspects of competence according to theoretical principles. The piloted instrument is used in several universities to get findings concerning the extent of physics student teachers' professional action competence and its development within the first phase of teacher training. Furthermore the interplay of the identified components of professional action competence is researched via statistical analyses.

S11.9.2 Effects of a Learning Cycle Lesson on Electromagnetic Radiation on the Achievement and Beliefs about Science Teaching Among Elementary Education Pre-Service Teachers

Kevin C. Wise, Southern Illinois University
Frackson Mumba, Southern Illinois University

The purpose of this study was to assess the effects of a learning cycle unit on the concept of electromagnetic radiation on the achievement and beliefs about science teaching among elementary education pre-service teachers in our teacher education program. The instructional intervention was a learning cycle unit on the characteristics of medium wave radio signals (530 kHz to 1710 kHz) as a form of electromagnetic radiation. A quasi-experimental design was employed in this study. A sample comprised 52 elementary education pre-service teachers at a national research university. Pre and post-tests on content knowledge and beliefs about science teaching were administered to participants before and after the intervention. Preliminary results show that after the intervention the experimental group gained more content knowledge and inquiry skills on electromagnetism than a control group. As such, this study demonstrates the effectiveness of a learning cycle model in enhancing pre-service teachers' content knowledge and pedagogical skills. However, both experimental and control groups' beliefs about science teaching did not substantially improve during this investigation. Implications on science teaching and teacher education will be discussed.

S11.9.3 Impact on Conceptual Understanding and Attitudes toward Teaching of Pre-Service Teachers in an Astronomy Course Designed Using Backwards Faded Scaffolding

Timothy F. Slater, University of Wyoming
Stephanie J. Slater, University of Wyoming

In response to national reform movements calling for future teachers to be prepared to design and deliver science instruction using the principles of inquiry, we created and evaluated a specially designed course for pre-service elementary education undergraduates based upon an inquiry-oriented teaching approach framed by the notions of backwards faded-scaffolding as an overarching theme for instruction. Students completed both structured- and open-inquiry projects and presented the results of their investigations several times throughout the semester. Using a single-group, multiple-measures, quasi- experimental design, students demonstrated enhanced content knowledge of astronomy and inquiry as well as attitudes and self-efficacy toward teaching as measured by the Test of Astronomy STandards (TOAST), the Science Teaching Efficacy Belief Instrument – Version B, and the Attitudes Toward Science Inventory.

S11.9.4 Fostering Pre-Service Teachers' Development of Pedagogical Content Knowledge in Physics

Mary Kay Kelly, University of Dayton
Todd B. Smith, University of Dayton

Preparing pre-service teachers to teach science at the early and middle level grades is a complex process. A key component of their educational experiences in preparation for science teaching is the development of pedagogical content knowledge (PCK). One of the difficulties in building PCK for pre-service science teachers is the disconnection between how they learn science content and how they are expected to teach science content to K-12 students. To minimize this problem, an introductory conceptual physics course was redesigned to serve the needs of pre-service teachers. The purpose of this study is to investigate how pre-service teachers' perceptions of their science content matter knowledge, pedagogical knowledge, and pedagogical content knowledge changed over the semester they were enrolled in physics course. Pre- and post-course attitudinal questionnaires were administered. Findings suggest that pre- service teachers who participated in the innovative physic class reported increases in their level of preparedness to teach science, their level of preparedness with respect to content knowledge in physics-related content, their level of preparedness with respect to teaching skills in physics-related and non-physics related content and processes, and their level of preparedness to use standards-based teaching practices.

S11.10 Strand 8—SC-Paper Set: Identity and Beliefs

S11.10.1 Connectedness and Trust as a Feature of Effective Mathematics and Science Professional Development

Therese Shanahan, UC Irvine
Silvia Swigert, UC Irvine
Tiffany Lockhart, UC Irvine
Asim Kazi, UC Irvine
Connie Tran, UC Irvine

This study of 66 mathematics and science teacher leaders (Pre-K to grade 12) from three districts in Southern California who received professional development in summer institutes and academic year meetings over the course of a comprehensive five year NSF Math and Science Partnership grant shows that they felt a strong sense of belonging from attending vertical team meetings with university faculty and Teacher Leader Directors. Based on surveys, focus group sessions, case study interviews, and classroom observations, results show that these teacher leaders' sense of connection encouraged them to use the lessons and strategies they experienced throughout the project that is the subject of this study. They trusted their Teacher Leader Directors to provide high quality professional development. A possible conclusion of this study is that participants need to feel a relationship with the professional developers in order to have the confidence to use the materials in their classrooms. A provider's content expertise is not enough to promote implementation.

S11.10.2 Science Teachers' Professional Identity and Beliefs with Relation to Reform Initiatives

Ji Y. Hong, University of Oklahoma
J. Steve Oliver, University of Georgia
Penelope M.D. Vargas, University of Oklahoma

The purpose of this study was to explore how science teachers' professional identity and beliefs are related when their practice involves enactment of reform mandates. Specifically, this study focused on how early career science teachers perceive and interpret the calls for inquiry-based instruction (as suggested by National Science Education Standards) in relation to their identity and beliefs. Further, this study explored how the school and classroom contexts influenced these early career teachers' implementation of the reform-based teaching practice. The findings of this study revealed that when teachers are exposed to externally generated norms, their existing beliefs about science teaching are challenged. Most often this was observed as a recursive relationship between teachers' perception of themselves as teachers and the use of inquiry-based instruction. Within this dynamic, teachers' beliefs and identity with regard to reform mandates were powerfully shaped by school and classroom contexts. For instance, if the school mediated the reform agenda in such a way that teachers felt an oppression of their autonomy, this threatened the teacher's identity. Consequently these teachers circumvented the reform effort by being unavailable for consideration of implementation of new instructional approaches. This paper ends with implications for teacher educators, school administrators, and policy makers.

S11.10.3 Secondary Science Teachers' Beliefs of Learning and Knowledge and their Influence on Inquiry-Based Practices

Christine R Lotter, University of South Carolina
Greg Rushton, Kennesaw State University
Jonathan Singer, University of Maryland-Baltimore
Bob Feller, University of South Carolina

This paper investigated 20 secondary teachers' beliefs about learning and knowledge and their use of inquiry-based practices in their classrooms after a year-long professional development program. The professional development consisted of a two-week summer workshop, five follow-up academic year workshops, and classroom observations during inquiry instruction. The teachers were interviewed before and after the summer workshop and again after the academic year using a semi-structured interview protocol that included the Teacher Beliefs Interview (Luft & Roehrig, 2007). The teachers' degree of reformed teaching during the academic year was measured with the Reformed Teaching Observation Protocol (Sawada et al., 2002). At the end of the academic year, the teachers who had changed their beliefs to be more student-focused also described changing their instructional practices to include more inquiry due to their experience in the professional development program. The teachers' understanding of inquiry and their beliefs about student learning and scientific knowledge influenced the quality (RTOP score) and quantity of inquiry instruction enacted in the their classrooms. This research highlights the need for professional development programs to make teacher beliefs explicit along with educating teachers on inquiry practices if reform-based practices are to be adopted.

S11.10.4 On the Road: Effectiveness of an Experiential Professional Development Program on Teacher Perceptions of Self and Science

Dina Drits, University of Utah
Adam Johnston, Weber State University
Stacy Palen, Weber State University

This study investigates an experimental professional development program engaging 15 teachers on a weeklong bus trip to science-intensive locations across three Western states. The goal of the program was to provide teachers with experiences that would foster a sense of excitement about, and a personal connection to, the nature of science, the process of conducting science and to scientists working in field locations. The research questions involved understanding teacher goals for the program, post-program teacher outcomes, alignment between teacher goals and outcomes, and alignment between teacher outcomes and leader goals. Data included pre- and post-program open-ended teacher surveys, open-ended leader surveys, and follow-up school year interviews with a sample of the participants. Analysis indicates that teacher expectations were met and that outcomes and goals for the program were aligned to a large degree. Changes in teacher beliefs about science shifted from seeking new lesson plans and activities to a broader and more affective interest in sharing with students the excitement and enthusiasm toward science gained from program participation. This work suggests a model by which to engage teachers in and foster more personal connections to science, potentially resulting in more meaningful science experiences for students in the classroom.

S11.11 Strand 8—Symposium: Graduate Level Teaching of Nature and Practice of Scientific Inquiry

Penny J. Gilmer, Florida State University
Steven Blumsack, Florida State University
Kate Calvin, Florida State University
Brenda Crouch, Panhandle Area Educational Consortium, FL
Douglas Smith, Vernon Middle School, FL
Tiffany Nichols, Carr Elementary and Middle School, FL
Irene Myers, W. R. Tolar K-8 School Bristol, FL
Daphne Hill, Jefferson County High School Monticello, FL
Caren Prichard, Chipley High School Chipley, FL

Many science teachers have not experienced authentic scientific inquiry, thereby making it difficult for them to teach with inquiry. To address this, we offered two graduate level courses by distance to 80 rural teachers from grades 3-12 to prepare them for teaching science through inquiry. The first was ÒNature of Scientific Inquiry,Ó delivered by videocast. This course prepared the teachers for the second course, ÒScientific Research Experiences.Ó Teachers conducted scientific research in articulated, collaborative teams with teachers, a teacher mentor, and scientists who worked near their school. For evaluation, we used the Views on the Nature of Science questionnaire before the first course and after the second course, plus reflective writing by the teachers during both courses. For dissemination, we have a monograph with chapters by a number of the teachers and a DVD documentary taken at the research sites of the monograph authors. Evidence suggests: 1) most teachers gained significantly in their understanding of scientific inquiry and in their enthusiasm for teaching science through inquiry, and 2) groups in which articulation was optimal in terms of grade representation and field work schedules, teachers were inspired to collaborate in vertical lesson planning and course building for their students.

S11.12 Strand 9—Symposium: Reflective Practics and Professional Development through Japanese Lesson Study

Michael Kamen, Southwestern University
Meredith Park Rogers, Indiana University
Khemmawadee Pongsnaon, Indiana University
Valarie L. Akerson, Indiana University
James Minogue, North Carolina State University
Sarah J. Carrier, North Carolina State University
Abdulkadir Demir, Georgia State University
Charlene M. Czerniak, The University of Toledo
Nonye M. Alozie, University of Michigan
Ji-Young Kim, University of Illinois at Urbana-Champaign

Ten science educators will share what they have collectively learned from their research on variety of applications of Japanese Lesson Study applications in preservice and inservice K-12 contexts as well as in higher education. Lesson study is a form of professional development widely used in Japan. It is gaining popularity in the United States and elsewhere as a way of building communities of practice, encouraging reflection on teaching, and focusing on student learning and student responses to instructional decisions. A brief presentation will describe a theoretical and pragmatic case for lesson study and then the presenters will illustrate outcomes and explore themes that cross projects. Following a short description of the nature of the research projects and contexts the presenters will engage the audience in a discussion about these themes. Themes that emerged include a discussion of how this collaborative process increases the depth of discussions about teaching; its impact on power relationships between teachers, preservive teachers and their cooperating teachers, and university professors and their students; data collection; the fidelity of lesson study, and the role of the observer. Constraints to implementation such as participants' conceptual understanding of lesson study, scheduling issues, collaborative planning, and time will be discussed.

S11.13 Strand 10—SC-Paper Set: Assessing Science Teacher Knowledge and Skills

S11.13.1 Using Survey of Enacted Curriculum (SEC) Data to Describe Baseline Physical Science Coverage for Illinois Teachers: Results of the Analyses for the Illinois Institute of Technology (IIT) Physical Science Initiative (PSI) Project for Chicago Public Schools

Erica L. Kwiatkowski-Egizio, Illinois Institute of Technology

The Survey of Instructional Content pre-test data from 2001-2006 of 294 urban K-8 teachers and 1240 non-urban K-8 teachers was analyzed. The SEC instructional practices and teacher preparation data was analyzed to develop a needs assessment for a graduate degree program leading to a Master's Degree and a middle school physical science endorsement. T-test results showed that there was not a significant difference in physical science coverage for urban and non-urban teachers. However, urban teachers report only 12.7 % in physical science coverage. Additional data analyses included: multiple regression, ANOVA, and ANCOVA. These results depicted professional development levels, class size, being from an urban setting, and other areas of science coverage, excluding physical science, as significant variables that affect physical science coverage for K-8 teachers.

S11.13.2 Assessing Effectiveness of a Science and Mathematics Teacher Development Program through Use of Virtual Comparison Groups

John F. Cronin, Northwest Evaluation Association
Jeff C. Marshall, Clemson University
Yun Xiang, Northwest Evaluation Association

This paper discusses a longitudinal evaluation design for a year-long professional development program in science and mathematics offered by a large southeastern university. The design measures growth in student achievement within the participating teachers' classrooms by using a state-aligned assessment instrument that reports results on a cross-grade Rasch-based scale. Results from the study group are compared with a virtual comparison group, which is created from a large, longitudinal database of student test results. To create a VCG, each student in a population of interest is paired with up to 51 other students who did not participate in the program who had the same starting scale score, received similar instructional time, shared relevant demographic characteristics, and came from schools with similar poverty rates and urban/rural settings. The evaluation follows three cohorts of teachers participating in the program over a three- year period. Student growth in the classrooms of the participating teachers is measured prior to beginning the program. Growth during and after the program is compared to the growth of the Virtual Comparison Group and to a population of students within the participating school systems whose teachers did not participate in the program.

S11.13.3 Can We Measure Teachers' Pedagogical Content Knowledge (PCK) Using Surveys? Developing Measures of PCK for Teaching High School Biology

Soonhye Park, University of Iowa
Jeongyoon Jang, University of Iowa
Ying-Chih Chen, University of Iowa

The purpose of this study was to develop two different types of measures to assess pedagogical content knowledge (PCK) for teaching biology at grades 9 and 10: a) survey- type measure (i.e., paper and pencil type test) and b) rubric-type measure. The measures focused on two key components of PCK: a) teacher knowledge of student understanding of a particular science concept and b) teacher knowledge of instructional strategies and representations. Furthermore, given the topic-specificity of PCK, the development of the measures centered on two topics in biology: photosynthesis and heredity. Acceptable reliability of the measures was established by Cronbach' ¥á and Pearson correlation coefficient (inter-rater reliability for rubric-type measure). Validity was tested in terms of content validity, construct validity using a confirmatory factor analysis, and concurrent validity using RTOP. In addition, a generalizability analysis was conducted to disentangle multiple sources of measurement error. Various error sources in the measures that are identified by the generalizability analysis and the importance and consequences of the error sources are discussed. Challenges and dilemmas that the research team has encountered in the course of developing the measures are also addressed.

S11.13.4 Correlated Science & Math: A New Model for Training Teachers to Link Both Disciplines

Sandra S. West, Texas State University - San Marcos
Lisa A. Gloyna, Texas State University - San Marcos
Mamta Singh, Texas State University - San Marcos
Melissa Duran, Texas State University - San Marcos

This study focuses on a new model of linking science and math instruction called Correlated Science & Math (CSM). Integrating science and math typically means science teachers using math as a tool or math teachers using a science as an application of a math concept. The CSM model is clearly defined where the concepts in each discipline are taught with two fundamental goals: (1) teach for conceptual understanding and (2) use the discipline's proper language. Five cohorts of both pre and inservice grades 5-8 teachers were trained using the CSM model. This study evaluates the level of impact of the CSM program on enhancing teachers' content knowledge, pedagogical skills and ability to use the CSM model in their classrooms. The study consists of five cohorts of pre-service and in-service teachers within the study time frame from the summer of 2006 through summer 2007. Preliminary results indicate that participating teachers (1) increased their content knowledge at a statistically significant level ($p < 0.05$); (2) adopted an integrated approach, not a CSM one. Further analysis will address student performance based on their pre and posttests, state science and math tests scores, student work samples, and classrooms observations.

S11.14 Strand 11—SC-Paper Set: Teacher Beliefs and Inclusive Science Teaching

S11.14.1 Urban Teachers' Beliefs and Practice of Contextualized Science Teaching

Younkyeong Nam, University of Minnesota
Hui-Hui Wang, University of Minnesota
Bhaskar Upadhyay, University of Minnesota

Through a case study approach, 4 urban elementary teachers' understandings and practice of contextualized science teaching and their beliefs about urban students were examined in detail. Six classroom observations and two semi-structured interviews with each teacher were used as main data collection methods. Findings reveal urban science teachers' understandings of students' everyday life where students experience nature world and cultural background can make significant impact on their science teaching. Teachers valued contextualized science teaching, which used scientific examples based on students' everyday life. However, teachers' lack of knowledge of their students' social and culture background could cause disconnections between their science teaching with their student's everyday life. Moreover, lack of educational support from school and school district about teaching urban students and lack of information in State science education standard also could cause their limted contextualixed science teaching. We strongly suggest that teachers need support and learning opportunities about their urban students especially about their home culture or ethnic group.

S11.14.2 Investigating Secondary Science Teacher's Beliefs about Multiculturalism and its Expression in the Classroom

Lori Petty, Texas Tech University
Ratna Narayan, Texas Tech University

The United States is a diversely rich and very populous nation. By including the term "all" in their "Science for all Americans" the American Association for the Advancement of Science (AAAS) believes that individuals from all cultures should be science literate. By adding a multicultural component to scientific literacy questions have been raised as to what should be taught in the science curriculum and how. Do secondary science courses have a multicultural component and if so, to what extent? This research will explore how multiculturalism pertains to secondary science classes; discuss the results found from a study conducted with secondary science teachers; and talk about any future implications. Data was collected through interviews with secondary principals and science teachers as well as classroom observations of the teacher's instruction of science content. From that data there were four themes that emerged: 1) student learning styles, 2) importance of multiculturalism, 3) integration of multiculturalism, and 4) school encouragement of multiculturalism. This research study provided a glimpse into the beliefs secondary teachers have about multiculturalism in their science classrooms. Teachers are generally unaware of what multicultural science is and how to incorporate into the everyday science curriculum.

S11.14.3 Using an Argumentation-Based Course to Explore Teachers' Cosmological Ideas

Meshach M.B. Ogunniyi, University of the Western Cape, South Africa

Since the collapse of the apartheid system of government in 1994, the new South African government has undertaken a major curriculum reform. To meet the challenges of the country's multi-cultural classrooms the Department of Education (DOE) introduced an inclusive curriculum known as Curriculum 2005 (C2005). One of the goals of C2005 is that teachers integrate science with Indigenous Knowledge Systems (IKS). In pursuance of this goal this study exposed a group of in-service teachers enrolled in a graduate science education class to an argumentation-based Nature of Science (NOS) and Indigenous Knowledge Systems (IKS) course. Adopting a case study approach involving the use of questionnaires, interviews and reflective essays, an analysis of the pre-test-post-test data suggests that although the teachers are well aware of the scientific notion of the origin of the universe, their overall cosmological ideas are largely dominated by their religious worldview. The implications of this finding for C2005 and instructional practices are worthy of closer attention.

S11.14.4 Virtual Environment for Ethical Sensitivity Assessment and Its Impact on Science Educators

Shawn Y. Holmes, North Carolina State University
Leonard A. Annetta, North Carolina State University
Meng-Tzu Cheng, North Carolina State University
Elizabeth Folta, North Carolina State University

Rapidly diverging student/teacher racial and ethnic demographics and assessment of educator dispositions heighten the need for strategies to influence science teacher disposition when teaching multicultural and multilinguistic students. Knowledge, skills, and professional disposition of science educators are central to educating, inspiring, and guiding students and are important for all students to become scientifically literate. This study investigates an intervention designed to promote professionalism and develop dispositions as they relate to scientific literacy. Fourteen preservice secondary science education students and 16 secondary science teachers participated in a computer simulation emulated from a valid and reliable video-based measure of ethical sensitivity. The assessment measures recognition of racial and gender intolerant behaviors in school settings situated in codes of ethics from school-based professions. In-simulation and post-simulation questionnaires determined participant ethical sensitivity and simulation experience. Video-based assessment scoring categories were used to code in-simulation responses. Preservice responses were classified as no recognition more often than inservice responses. Both groups overall had fewer responses classified as recognition and elaboration showing complexity of the issues portrayed. Sixty-five percent of all participants reported attending previous ethics/multicultural workshops for professional development. Post-simulation responses indicate the virtual experience provided an interactive, personal, empathic, and reflective environment.

S11.15 Strand 12—SC-Paper Set: Multiple Perspectives on Evaluating Technology-Rich Learning Environments

S11.15.1 Edutainment Software Programs in the Genetic Course: Ten Grade Students' Science Process Skills and Attitudes toward Science

Yilmaz Kara, Karadeniz Technical University, Turkey

The purpose of this study was to investigate the effects of edutainment software program used computer assisted instruction on tenth grade students' science process skills and attitudes toward science. The sample of this study consisted of 48 students, from two different tenth grade classrooms in a high school, which were instructed by the same science teacher. The classrooms were assigned randomly as the control group and the experimental group. In the experimental group, edutainment software program was employed along with computer assisted instruction; whereas in the control group, the same content were employed using traditional instruction. In order to assess the treatment effects on tenth grade students, Science Process Skills Test (SPST) and Attitude Scale toward Science (ASTS) were administered as pre- and post-test to the control and experimental groups. Pre- tests were used as covariates. The results of ANCOVA showed that students in the experimental group had better performance on Post-SPST scores and Post-ASTS. Key words: science process skills, edutainment software programs, computer assisted instruction.

S11.15.2 The Impact of Implementing Technology-Enabled Active Learning (TEAL) on Student Learning in Taiwan

Ruey S. Shieh, Tatung Institute of Commerce and Technology
Jawluen Tang, National Chung Cheng University

Abstract Collaborating with Massachusetts Institute Technology, National Chung Cheng University (NCCU) in Taiwan brought in the idea of Technology-Enabled Active Learning (TEAL) to its campus in 2004. TEAL is an innovated format of teaching and learning, featured with media-rich software for simulation and visualization to facilitate students learning science and technology-related subject matters. In the spring of 2008, there were four classes studying the General Physics course using the TEAL studio (experimental group), whereas five were taught in the traditional classroom (control group). The purpose of this study is to examine the learning effect the experimental group achieved, as opposed to that of the traditional group. Data sources include pre- and post tests, and end-of-semester surveys. The findings indicate that the overall average of the test difference (posttest ¡V pretest) of the TEAL group is significantly higher than that of the traditional group (p value < .001). Although the average of maximum possible gains of the TEAL group appears relatively small compared with those reported by earlier researchers, the significant positive learning gain, however, is encouraging for future implementation of the technology-enable active learning instruction.

S11.15.3 PowerPoint in the Science Classroom: Reforms-Based Instruction or High-Tech Chalk & Talk?

Christine G. Schnittka, University of Virginia
Ian C. Binns, Louisiana State University
Randy L. Bell, University of Virginia

This descriptive study was set within the context of a science teacher preparation program informed by situated learning theory. The investigation explored how twenty-seven secondary preservice science teachers comprising two cohorts of students, used presentation software (i.e., PowerPoint) to support science teaching and learning. The research questions that guided the investigation included (a) whether teachers prepared to teach with technology from a situated learning theory perspective use presentation software to support reforms-based science instruction, and (b) if so, what form their instruction would take? The extensive data collected to answer the research questions included formal and informal interviews, classroom observations, lesson plans, and presentation software files. The researchers used analytic induction to analyze the data. Results indicated that the secondary preservice science teachers used presentation software in a variety of ways that, in general, supported reforms-based science instruction. Additionally, the results serve as exemplars of effective ways to use presentation software. Among other implications, the results reflect the efficacy of a situated cognition perspective in preparing science teachers to use educational technology to support reform-based teaching.

S11.15.4 Factors that Compromise the Potential of Technological Tools in Fostering Authentic Inquiry in Science Classrooms

Noemi Waight, University at Buffalo, SUNY
Fouad Abd-El-Khalick, University of Illinois at Urbana-Chmpaign

This study examined the complex layers and processes inherent to the development in scientific contexts, and the adoption for teaching in high school science classrooms, of two technological tools: Biology Student Workbench and ChemViz. Participants included key players along the path of development, transformation, and implementation including scientists (8), programmers and developers (4), researchers and teacher educators (4), classroom teachers (6), high school students (30). Data collection included two phases of in-depth interviews, classroom observations, and collected artifacts. Classroom enactments of the tools lacked elements of inquiry and were teacher-centered with prescribed convergent activities. Consequently, students were preoccupied with a focus on content and guided instructions. The "desired" and "actual" realizations of the tools fell on two extremes that reflected the disparity between scientists' and teachers' views on science, inquiry science teaching, and the related roles of the tools. The views of educators and programmers were more closely aligned with teachers' views than with the scientists. Research on the adoption of technological tools for classroom teachers should expand to examine the role of scientists, researchers, and teacher educators as compared to the current narrow focus on teacher knowledge, skills, beliefs, and practices.

S11.16 Strand 13—Symposium: Should Pseudoscience Studies Become an Integral Part of NOS and Scientific Inquiry Curricula?

Julie Gess-Newsome, Northern Arizona University
Norman G. Lederman, Illinois Institute of Technology
Ron Good, Louisiana State University
Mike U. Smith, Mercer University
Lawrence C. Scharmann, Kansas State University

The study of the Nature of Science (NOS) and Scientific Inquiry (SI) in science education circles has increased a great deal since Science for All Americans was published in 1989 and the History and Philosophy of Science in Science Teaching group met for the first time in Tallahassee. In the following two decades much good thinking has gone into the question of how science 'gets done' and what scientific knowledge is all about, but pseudoscience has not been explicitly included in these studies. It seems to be assumed that if one can say the right things about NOS and scientific inquiry, then recognition and understanding of pseudoscience will automatically follow. However, there is ample evidence to the contrary. This symposium will consider whether pseudoscience studies should become an integral part of curricula focusing on NOS and scientific inquiry and, if so, how that might be accomplished.

S11.17 Strand 15—SC-Paper Set: The Long View: How Science Education Policy is Made and Changes over Time

S11.17.1 Ups and Downs Ranking of Science Education Institutional Research Productivity

Lloyd H. Barrow, University of Missouri
Nai-En Tang, University of Missouri

The purpose of this study was to compare the domestic science education programs where the science education researchers published their research with the 1990's (Authors 2008). Each issue of the eight research journals (Journal of Research in Science Teaching, Science Education, International Journal of Science Education, Journal of Science Teacher Education, School Science and Mathematics, Journal of Computers in Math and Science Teaching, Journal of Science Education and Technology, and Journal of Elementary Science Education) published from 2000-2004 provided the author(s) and their institutional affiliation. The resultant ranking of the top 30 science educations programs shows variation in journals where research was published. There have been drastic changes among the top 10 from the 1990's with four institutions no longer ranked. The top five institutions for 2000-04 were: University of Michigan, Indiana University, University of Georgia, Arizona State University, and University of California – Berkeley.

S11.17.2 A Qualitative Study Examining Ontario Science Curriculum Policy-Making Development and Decision Making Processes from 1985 to 2008

Marietta Bloch, Roehampton University, UK

This session describes the design of a current doctoral study that uses a non-traditional policy trajectory approach to uncover the development and decision-making processes in one jurisdiction's science curriculum policy-making since 1985. Central to this design is the work of Bowe, Ball and Gold (1992) in developing a policy cycle approach of three interrelated contexts. The context of influence, the context of policy text production and the context of practice, all provide an analytical framework to examine the multidimensional complexities of science curriculum policy-making. Although the data analysis for this doctoral study is still ongoing, this design approach is useful in uncovering the complex and multidimensional processes of science curriculum policy-making. Using a trajectory approach with embedded policy cycles for each government-developed science curriculum document enables an examination of patterns and trends that influence science curriculum policy-making as well as who is involved. Final completion of this study with its findings and implications is expected in 2009.

S11.17.3 Single Gender Education in Science: Policy Issues and Implications for Research

Amber R. Jarrard, University of Georgia
Julie Kittleson, University of Georgia

Single gender education for girls in science has steadily been gaining publicity. With much research available suggesting the benefits of single sex education for girls in science, it makes the potential of the situation difficult to ignore. With recent changes in legislation, which loosened the tight grip of restriction on separation in schools, we begin to see a renewed interest in this topic. Policy plays a critical role in the trend of single sex science education, and serves as a point of confusion and frustration to many school systems. Even with new interpretations and legislation in place, there are unclear points of experimenting with single gender education, which serve as a turn off to school systems wishing to implement it with their students. These systems are wary of the ambiguities in the legislation and refer back to unfavorable court cases of similar nature, which they would rather avoid for themselves. This position paper explores the history of school separation; the current and compelling research on girls' performance in single gender science classes, as well as policy implication and suggestions for future reform with regard to science education.

S12.1 International Committee Sponsored Session—Symposium: Approaches to Teaching and Learning Science that Foster Interest and Understanding: Examples from Australia and New Zeland

David F. Treagust, Curtin University, Australia
Christine Howitt, Curtin University, Australia
Elaine Blake, Curtin University, Australia
Gillian Kidman, Queensland University of Technology
Garry Hoban, University of Wollongong, Australia
Philemon Chigeza, James Cook University, Australia
Kimberley Wilson, James Cook University, Australia
Kathy Brazier, University of Waikato
Deborah Corrigan, Monash University

This presentation is designed to present six research projects taking place in Australia and New Zealand that are somewhat representative of this type of initiatives. Two of the research projects primarily involve preservice teachers at early childhood (Howitt & Blake) and at secondary school (Kidman & Hoban); three projects with middle school indigenous students (Chigeza), disengaged students (Wilson et al.), secondary students (Brazier & Rennie) and one project with practicing teachers (Corrigan et al.)

S12.2 Research Committee Sponsored Session—Technology Symposium: Grand Challenges in Technology Enhanced Learning in Science

Marcia Linn, University of California, Berkeley
Robert Tinker, The Concord Consortium
Douglas Clark, Arizona State University

The Technology Enhanced Learning in Science (TELS) center is creating a new vision for the effective use of information technologies in STEM learning. Participants in this session will be able to explore materials designed to support student learning through guided inquiry of dynamic visualizations, collection of experimental data in real time using probes, and linkages between visualizations and experimental data. Attendees will conduct experiments with temperature-sensitive probes and link the graphs to visualizations of molecular movement as one of many examples. They will be able to critique existing curriculum materials using these resources and design their own research investigations. Free, customizable resources developed by TELS will be introduced and participants will be provided with information about their impact. TELS has created new resources for researchers, an improved approach to the design of materials based on design principles and patterns, a platform for developing, deploying, and studying the materials, a targeted professional development program, a national test-bed of diverse schools and teachers, and new assessments. Facilitators will respond to questions about how to use these materials in research programs. Participants will receive electronic copies of slide presentations, papers, curriculum materials, and lesson plans.

S12.3 Strand 1—SC-Paper Set: Textbooks, Reading and Writing Science

S12.3.1 A Study of Statements of Lexicon Relations and Students' Understanding Ii Science Textbooks

Shih Wen Chen, Chung Zhen Primary School, Taiwan
Wen Gin Yang, National Taiwan Normal University, Taiwan
Min Shiung Chuang, National Kaohsiung Normal University, Taiwan

This study aimed to identify the statement forms of interpreting the lexicon relations of classification and composition in science textbooks and to explore students' understanding on these forms. Three textbook versions of junior high school were chosen as the analysis materials and were analyzed by STAR program to examine the statement forms. Moreover, 65 eighth grade junior high students participated in this study and were asked to fill out a questionnaire of MAST after reading a target text which excerpted from the matter and atom topic. Then the data would be analyzed by a program of Repertory Grid Technique (RGT) for exploring students' understanding of the forms. The results showed the statements forms of interpreting classification and composition were diversely, including various verbs, prepositions, and even the punctuation. Some forms could explicitly indicate the specific lexicon relations, but some forms were implicitly. Additionally, students could recognize and distinguish the classification and composition, but they could not definitely identify the different composition, and also argued the implicit forms were not appropriate to interpret the lexicon relations. Finally, the results of this study could offer some implications for science teaching and further studies in improving science understanding.

S12.3.2 A Secondary Reanalysis of Student Perceptions while Participating in Non-traditional Writing in Science

Mark A. McDermott, University of Iowa
Brian Hand, University of Iowa

As writing-to-learn strategies in science continue to gain support, research is attempting to clarify the best ways to design writing tasks to encourage conceptual growth. In this study, focus is shifted to perceptions of students participating in writing-to-learn activities. A secondary reanalysis methodology is employed with the intent of gaining generalizations from multiple student interviews taken as a part of several independent research studies that have been undertaken as part of a research program over the past decade. Assertions gathered from this analysis indicate student recognition of the benefits of these types of activities when particular task characteristics are present due to increased cognitive activity. These general assertions align with many of the specific assertions from the original studies.

S12.3.3 Discernment of Referents - An Essential Aspect of Conceptual Change

Helge R. Stroemdahl, Linköping University, Sweden

By a two dimensional semantic/semiotic analysis schema, acronym 2-D-SAS, the semiotic properties and the polysemy of words used in science education are made explicit by discerning on the one hand the word as a symbol, concept and referent, and on the other hand a set of senses comprising non-formal senses, scientific quality senses and physical quantity senses. The general educational value of the 2-D-SAS approach is threefold: a) to stress the polysemy, the space of meaning, the 'sense-spectrum', of words, b) to explicitly identify the referent as the base for modelling a concept, and c) identifying that a word can denote both a quality and a physical quantity. The relevance of the referent in conceptual learning has been neglected as an explicit analytical approach in mainstream conceptual change research. The potential of the present approach is illustrated by eliciting the well known recurrent problem among students to learn the separate scientific meaning of heat and temperature by discerning the critical features of the intended learning object.

S12.3.4 Understanding Secondary Students' Acquisition of Scientific Literacy

Paul J. Preczewski, Syracuse University
Alexandra Mittler, Syracuse University
John W. Tillotson, Syracuse University

Scientific literacy is a major educational and political goal worldwide, yet the development and enhancement of scientific literacy are not well understood. In order to better understand scientific literacy at the level of everyday science meaning making and a person's ability to address scientific questions, this study reports on findings from semi-structured interviews of 9 German and 5 American secondary students. We report on these students' conceptions of their science interactions in everyday life and their ideas about scientific literary. By conducting the same interviews in the native languages of students representing two countries known for emphasis on improving secondary science education's literacy enhancement, we learn from a cultural and contextual spectrum of science experiences. Our findings include three distinct themes independent of the educational setting. In addition, we find the recurrent and prevalent theme of German students' practicing science in nature not mentioned by American students.

S12.3.5 In What Ways do Students Attend to Prose and Graphics When reading Science Texts?

Mary H. van de Kerkhof, University of Michigan

Science texts frequently employ words and accompanying graphics to communicate information. In order to help students utilize texts as a means of accessing scientific information, and to help them take advantage of this access as another tool in learning science, we must understand how students use prose and graphics when reading. However, research has yet to provide a coherent picture of the ways students integrate multiple representations in science texts. This study poses the question: In what ways do 6th graders engage with and use prose and graphics when reading science texts? I have interviewed 20 sixth grade students in four reading-ability groups (ranging from struggling to proficient) in which they read two science texts and responded to comprehension, metacognitive and interest questions. This paper specifically reports ways students attend the prose and graphics, and why they do so, with respect to their reading abilities. Students' self reports indicate that students do look at graphics, at various points in the reading process, no matter if in the struggling, proficient or in-between groups. Prominent responses when asked why they looked at a graphic include: interest or curiosity in the graphic; attributes of the graphic; spatial relationship between the prose and graphics; connecting information among prose and graphics; the graphic helps and to learn more. Subsequent analyses will include case-by-case analysis to further support trends that may exist among reading ability groups.

S12.4 Strand 1—Symposium: Supporting Student and Teacher Learning about Modeling Practices

Andres Acher, Northwestern University
Hamin Baek, Michigan State University
Jing Chen, Michigan State University
Michelle Cotterman, Wright State University
Elizabeth A. Davis, University of Michigan
David Fortus, Weizmann Institute of Science
David Grueber, Wayne State University
Hayat Hokayem, Michigan State University
Barbafa Hug, University of Illinois at Urbana-Champaign
Lisa Kenyon, Wright State University
Joe Krajcik, University of Michigan
Michele Nelson, University of Michigan
Gerald Rau, University of Michigan
Christina Schwarz, Michigan State University
Yael Shwartz, Weizmann Institute of Science
Tang Wee Teo, University of Illinois at Urbana-Champaign
Jodie Wilson, Wright State University

Modeling is a core component of scientific practice, yet it is rarely incorporated into educational experiences of elementary or middle school students. We aim to determine what aspects of the practice can be made accessible and meaningful for children and how we can support teachers in overcoming these challenges. Our framework for scientific modeling includes the performances of the practice (constructing, using, evaluating and revising scientific models) and the metaknowledge that guides and motivates the practice (e.g., understanding the nature and purpose of models). In this interactive symposium, we will present an integrated set of posters addressing various aspects of supporting learning modeling practices for both students and teachers. All the work stems from a shared conceptualization of modeling practices as modeling performances and metamodeling knowledge. The work with students explores both elementary and middle school students engaged in modeling with a range of science content. In this work we identify the aspects of modeling performances and metamodeling knowledge that student develop, and the challenges that emerge. The work with teachers examines preservice teachers growth in understanding of modeling as they engage in teacher education activities designed to promote their pedagogical content knowledge about scientific modeling.

S12.5 Strand 2—SC-Paper Set: Exploring Teacher Practices and Student Perception in Science Education

S12.5.1 "Are You Curious As To Whether Crayfish Have A Sweet Tooth Or Not?" Teacher Questioning In Inquiry-Based Science Classrooms

Alandeom W. Oliveira, University at Albany, SUNY

This study examines elementary teachers' emergent social understandings while participating in a summer institute in which they were introduced to the scholarly literature on teacher questioning as well as their oral employment of questions while facilitating inquiry science lessons prior and subsequent to the institute. A grounded theory analysis revealed that teachers became increasingly aware of the social implications of the questions commonly posed by instructors. More specifically, teachers demonstrated an increased awareness of the authoritative functions served by discursive moves such as display questions, cued and retrospective elicitation, convergent questioning, and verbal cloze. Furthermore, a microethnographic analysis revealed that after the institute teachers demonstrated an increased ability to share authority with students by strategically adopting teacher questioning strategies that were relatively more student-centered, that is, focused on students' thinking and articulation of their own ideas and individual experiences (as opposed to student recall of scientific words, shared classroom experiences and standard science concepts); divergent or open-ended; reflective; and sincere. Based on these findings, it is argued that educators who set out to prepare teachers to effectively teach science through inquiry ought to go beyond the simple provision of static and ill-defined labels such as "guide" and "active inquirer."

S12.5.2 Chinese Students' Interest of Science Learning: Preliminary Findings from the ROSE Study in Three Cities of China

May Hung Cheng, The Hong Kong Institute of Education
Yau Yuen Yeung, The Hong Kong Institute of Education

Based on the international research project called "Relevance Of Science Education " (ROSE) which has been started in 2003 to study students' attitudes towards science in more than 40 countries, we have for the first time been able to collect data from Chinese learners in China. In 2007, a Chinese version of the ROSE instrument, which was appended with certain localized or Chinese-culture related questions to probe for the students' socio- economic background, was administered in eight secondary schools in each of the three Chinese cities, namely Hong Kong, Guangzhou and Shanghai, obtaining a total of 2,426 valid questionnaires from 70 classes of students plus 251 student interview records. From our exploratory factor analysis, 24 key factors are identified and 11 of them are related to the science topics about which the students want to learn. Using the partial credit Rasch model, quantitative comparison is made across the three cities between students' level of interest in various science topics vs gender, socioeconomic factors and banding of their schools. Finally, we shall briefly discuss the likely reasons for the differences between the students' science interest in Hong Kong and mainland China.

S12.5.3 Exploring the Relationship between Teacher Content Knowledge and Student Learning

Sean Smith, Horizon Research, Inc.

This study explored the relationship between teacher content knowledge and student learning in middle grades force and motion instruction. Recognizing a lack of psychometrically sound measures, we created valid, reliable assessments of teacher and student knowledge through a three-year development cycle. This process involved domain specification, expert review, cognitive interviews with teachers and students, and large-scale piloting and field-testing. In the research study, 25 teachers completed the teacher assessment before teaching a unit on force and motion, then gave the student assessment to their classes (N=1,730 students) immediately before and after the unit. Analysis of the results using hierarchical linear modeling (HLM) suggests a significant and positive relationship between teacher knowledge and student learning. In addition to this finding, the study provides much needed measurement tools for investigating this complex relationship.

S12.5.4 American Muslim Students Perceptions of Science and Science Learning: An Exploratory Study from a Private Islamic School

Sara L. Salloum, Long Island University - Brooklyn Campus
Saouma BouJaoude, American University of Beirut

This exploratory study aimed to explore middle school Muslim students' views about nature of science (NOS), theories of Evolution and Big Bang, their perceptions of science learning experiences, and relations between different students' perceptions. Qualitative research methods were used. Data sources were open ended-questionnaires about NOS and perceptions of science learning, flash cards response about theories and scientists, and an interview with the science teacher. Participants of this study were grade 8 and 9 Muslim students in a private Muslim school in a U.S. city. It was found that students held partially adequate views of the empirical NOS and to a certain extent the tentative NOS. They held less adequate views about theory-laden NOS and distinction between scientific theories and laws. All students saw learning science as important with four themes emerging for its importance: accumulating knowledge, utilitarian, a way to explain the world, and a hybrid perspective. There was little mention of religion when students were asked about other important subjects. Students saw theories as tentative and expressed opinions about evolution and the Big Bang. Students expressed enjoying labs in science which enhanced their emerging conceptions about the empirical NOS of science. Implications of the findings are presented and discussed.

S12.6 Strand 2—Related Paper Set: Understanding Identities and Disposition

S12.6.1 Learning To Teach as Identity Re/Production

Jennifer Adams, Brooklyn College of the City University of New York

The consistent need for qualified science and math teachers in New York City makes it necessary to find a pool of talented aspiring teachers committed to teach in the city's schools. Although there are several alternative route programs that train people to teach in NYC's schools, many of these teachers enter the classrooms with insufficient education coursework and are often assigned to low-income, non-white, and/or underperforming schools, leaving these schools at a greater disadvantage as many of these teachers leave after their minimal commitment. Preparing a cadre of home-grown urban science and math teachers could help to fill the need for qualified teachers with a commitment to teach in NYC's schools. The program recruits high-performing high school seniors who desire to be math and science teachers in NYC's public schools. Using cogenerative dialogues as a research methodology and identity development as a theoretical lens, this study examines the experiences of these students as their identities changed from urban students to urban secondary science and math teachers. The students (3-5 participants per session) met during bi-monthly 45-minute sessions where they discussed their experiences in their courses and host classrooms and cogenerated ideas to improve their teaching and their experiences of negotiating different structures (administrative, pedagogic, etc.) within the school. These sessions were videotaped and earlier sessions were replayed at later sessions for students and the researcher to examine evidence of growth and collectively determine experiences salient to their identity changes. During the first year of the study, many cogenerative dialogues focused on the aspiring teachers' ideals about becoming teachers versus the reality they experienced in their host schools. The year saw a growth in confidence and effective teaching dispositions of the students involved in this study.

S12.6.2 Science, Cogenerative Dialogues and Maria: Providing a Venue to Improve the Science Experiences of Physically Disabled Children

Gillian U. Bayne, Lehman College of the City University of New York

While some research using cogenerative dialogues has involved students with learning disabilities, this research is the first of its kind in that it provides insights into the lifeworlds, science experiences and science identities of physically disabled children. The need to address environmental factors (such as pain, fatigue, and absenteeism) and psychological factors (such as motivation, self-concept, and social-emotional problems) that affect the academic performance of physical disabled children has been well documented (Heller, et. al, 1996). This research illuminates, through meso-level ethnography and micro-analyses of videotape, the transforming culture of a class of ninth grade science students and their science identities, as they engage in cogenerative dialogues. A particular focus is placed on the developing agency, classroom participation and struggles of Maria, a student afflicted with Osteogenesis imperfecta (also known as brittle bone disease). Findings from this research evidence the progression of individual and collective responsibility for science teaching and learning. Examples of successful and unsuccessful encounters, cultural alignment and misalignment, student agency and class culture through meso and micro-analyses, all provide a deeper understanding of the dynamics of an urban science classroom and the solidarity that this class generated through interstitial culture. Understanding these teacher and student (especially Maria's) transformations has far-reaching implications for improving science education at a variety of levels.

S12.6.3 Where's the Beef? In Search of Science Content Knowledge in Cogenerative Dialogues

Femi Otulaja, City University of New York

This research study investigates the use of cogenerative dialogues as a means to understand and bridge differences that arise in a ninth grade urban science classroom. The teacher, who had several years of success working with other ninth grade students using cogenerative dialogues, failed to encourage this particular class initially to become involved in them, despite the overall frustration that was felt about how teaching and learning had been taking place. In this study, I integrate critical ethnography with video and conversation analyses at the macro, meso and micro levels via a pastiche of theoretical frameworks including cultural sociology, sociology of emotions and complex social encounters. The examination of the unfolding of social life in the science classroom as it is related to structure and agency dialectics (Sewell, 1992) also took place. The use of these frameworks and lenses allows me to identify, analyze, and categorize vignettes of social life into patterns of coherence and contradictions, while examining the details of encounters, specifically, interactions and transactions. Through this study, understanding related to the capital exchange cycle (Bourdieu, 1986) emerged. Enacting cogenerative dialogue enabled the resolving of contradictions that arose from shared experiences in the science classroom. While initial discussions centered on ameliorating teacher and students' pedagogical and classroom practices and building entrainment and solidarity around science learning, discussions soon give way to talking, arguing and asking questions about science content covered in the classroom. Differences were bridged, affording both students and teachers to confidently facilitate and engage in science discourse fluently. Cogenerative dialogues enabled the bringing of science into and out of the lived-experiences of urban students.

S12.6.4 From Rap to Chemistry: Using Culturally Adaptive Practices to Teach and Learn Chemistry

Nader Markarious, University of Pennsylvania

This research study investigates the use of cogenerative dialogues as a means to understand and bridge differences that arise in a ninth grade urban science classroom. The teacher, who had several years of success working with other ninth grade students using cogenerative dialogues, failed to encourage this particular class initially to become involved in them, despite the overall frustration that was felt about how teaching and learning had been taking place. In this study, I integrate critical ethnography with video and conversation analyses at the macro, meso and micro levels via a pastiche of theoretical frameworks including cultural sociology, sociology of emotions and complex social encounters. The examination of the unfolding of social life in the science classroom as it is related to structure and agency dialectics (Sewell, 1992) also took place. The use of these frameworks and lenses allows me to identify, analyze, and categorize vignettes of social life into patterns of coherence and contradictions, while examining the details of encounters, specifically, interactions and transactions. Through this study, understanding related to the capital exchange cycle (Bourdieu, 1986) emerged. Enacting cogenerative dialogue enabled the resolving of contradictions that arose from shared experiences in the science classroom. While initial discussions centered on ameliorating teacher and students' pedagogical and classroom practices and building entrainment and solidarity around science learning, discussions soon give way to talking, arguing and asking questions about science content covered in the classroom. Differences were bridged, affording both students and teachers to confidently facilitate and engage in science discourse fluently. Cogenerative dialogues enabled the bringing of science into and out of the lived-experiences of urban students.

S12.7 Strand 4—Related Paper Set: Development of Teacher Beliefs and their Instructional Practice

S12.7.1 Dutch and German Chemistry Teachers' Beliefs about the Curriculum and about Teaching and Learning

Jan Van Driel, University of Leiden, The Netherlands

In this paper, we report on a study of the beliefs of chemistry teachers about the teaching and learning of chemistry in upper secondary education in The Netherlands and Germany. The study was conducted in the context of a national revision of the chemistry curriculum in both countries towards a context-based approach. Chemistry teachers' beliefs were investigated using a questionnaire which focused on both content-related ideas about the chemistry curriculum and general educational beliefs. The questionnaire was administered to a sample of Dutch chemistry teachers and to a sample of German chemistry teachers. Results indicated that the beliefs of Dutch and German chemistry teachers, most of whom had more than 15 years of teaching experience, were quite similar. In both countries, teachers tended to support three curriculum emphases, almost to the same extent. The strongest support was given to the curriculum emphasis 'Fundamental chemistry', in which the main aim is to introduce students to the fundamental concepts and skills within chemistry, so as to prepare them for future training. This emphasis, however, contrasts with the aims of the current innovation of the chemistry curriculum in The Netherlands and Germany. Implications for the professional development of teachers are addressed.

Beliefs and Practices of Beginning Secondary Science Teachers: The First Two Years in the Classroom

Sissy Wong, Arizona State University, Tempe
EunJin Bang, Iowa State University
Julie A. Luft, Arizona State University
Krista Adams, Arizona State University
Jonah Firestone, Arizona State University
Jennifer Neakrase, Arizona State University
Ira Ortega, Arizona State University

While it is generally acknowledged that induction programs are important, little is known about the development of content specialists in these programs. In order to add to the knowledge in this area, this study follows 114 secondary science teachers as they participate in one of four different induction programs. The data collected consisted of observations of practice, reports of practice, and interviews about beliefs. Over a two year period, there were 8 observations of each teacher in his/her classroom, 16 interviews about classroom practice, and three interviews about beliefs. The analysis of the data revealed that as a group the beginning teachers held teacher-centered practices and beliefs. Analysis by induction program, however, revealed that teachers who participated in science-specific induction programs strengthened their beliefs and used more investigations in their classroom lessons than did their peers in the other induction programs. This study suggests that induction programs for content-specialists are essential in developing practices and beliefs aligned with the reforms. In fact, without these programs it is unlikely that teachers can achieve the reformed based practices called for in the National Science Education Standards (National Research Council, 1996).

S12.7.3 Biology Teachers' Attitudes and Beliefs towards Competence-Oriented Teaching and Their Instruction Practice

Markus Lücken, Leibniz Institute for Science Education, Kiel, Germany

National education standards for biology instruction were recently introduced in Germany. Accordingly teachers had to implement a new competence-oriented approach. The project "Biologie im Kontext" (bik) attempted to support teachers in implementing these standards. Teachers, researchers, and representatives of educational administration closely ("symbioti-cally") cooperated in developing the new instructional approach. The development of teach-ers' attitudes and beliefs towards the new approach and changes of their instructional behav-ior were carefully evaluated. The "Theory of Planned Behavior" (Ajzen, 1991) served as a model to predict teachers' instructional behavior and their impact on students' competences. In a longitudinal research design, using 3 measuring times, 78 teachers and their classes (1689 students) participated. The results of the study confirmed parts of the model and revealed that changes in teachers' attitudes concerning the implementation of competence-oriented teaching developed more slowly than changes in their self-efficacies and intentions to implement the new approach of teaching. Analyzing students' views on classroom activities only small in-creases of the competence-oriented classroom activities are revealed in the first year, but sig-nificant positive changes of the quality of student centered teaching and other criteria of good teaching.

S12.7.4 Development of Physics Teachers' Beliefs about Good Instruction and Their Instructional Behaviour

Silke Mikelskis-Seifert, Leibniz Institute for Science Education, Kiel, Germany
Reinders H. Duit, Leibniz Institute for Science Education, Kiel, Germany

"Physics in Context" (Piko) is a project funded by the German Ministry for Education and Research. 15 teams of some 10 teachers each from 11 of the 16 German federal states participate. The key goal of the project is to improve the range and quality of teachers' thinking about teaching and learning physics as well as their teaching behaviour by developing new teaching and learning methods. The process of improving teachers' thinking is deliberately supported. Evaluation includes teacher and student measures. Results of the evaluation show that teachers in general are very pleased with their work in Piko. The results of evaluation are encouraging – on the student side and regarding teacher professional development. It turns out, for instance, that teachers are of the opinion that their thinking about instruction and also their instruction developed substantially during participation. However, it also became clear that there are significant differences between the participating sets. It seems that intensity of coaching and reduction of teaching load are essential factors for fruitful development. Further studies are needed to investigate the role of theses factor in more detail. It is also necessary to rethink the scales used to measure teacher beliefs.

S12.8 Strand 5—SC-Paper Set: Innovations in Instruction

S12.8.1 Exploring Changes in University Instructor Thinking: Influence on Contextual Factors within a Departmental Teaching Culture

Erika G. Offerdahl, North Dakota State University

The practice of teaching is highly complex and is influenced by multiple factors. Gess- Newsome et al. (2003) represented the complex nature of teaching with the Teacher- Centered Systemic Reform (TCSR) model, which emphasizes the simultaneous influence of personal and contextual factors on instructor thinking and practice, and vice versa. Contextual factors include elements such as the physical setting, subject area taught, departmental and university culture, and department head or college dean. Prior teaching experience and individual experiences with learning are examples of personal factors. They both impact instructor thinking, an instructor's thoughts, beliefs, and attitudes about teaching, students, and learning. The purpose of the study was to explore the relationship between instructor thinking and contextual factors, particularly contextual factors within a departmental culture. The research presented here is a single case study (Stake, 1995) of Brian, a university instructor and department head. Specifically, this study explores the relationship between changes in Brian's instructor thinking and his actions as department head that influence contextual factors within the department. Three types of actions influencing contextual factors emerged: assessment-related, reflection-related, and activities related to scholarship in teaching. These findings have implications for future studies exploring factors that influence change in departmental teaching cultures.

S12.8.2 Scientific Reasoning and Epistemological Commitments: Coordination of Theory and Evidence among College Science Students

Ava A. Zeineddin, Wayne State University
Fouad Abd-El-Khalick, University of Illinois

This study examined the relationship between epistemological commitments and scientific reasoning among college science students. Prior knowledge was considered an intervening factor. Participants were 139 college students enrolled in two physics courses in a large Midwestern university. They completed an online questionnaire, which assessed their prior knowledge (PK) regarding buoyancy in liquids and epistemological commitment (EC) to the consistency of theory with evidence. Responses to the online questionnaire were used to select 40 participants with varying levels (high versus low) of PK and EC. These participants were divided into four groups, each with 10 students, representing four conditions. These groups allowed using a 2x2 factorial quasi-experimental design. The quality of participants' reasoning was assessed during individual interviews, which presented them with four problem solving tasks involving objects immersed in water. Two-way analysis of variance (ANOVA) indicated the absence of interaction between PK and EC. Controlling for one predictor, the mean reasoning scores between low and high levels of the other predictor were significant. The results showed that the higher the epistemological commitments were, the higher the quality of reasoning was for comparable levels of prior knowledge. Additionally, prior knowledge impacted reasoning more strongly when epistemological commitments were weaker.

S12.8.3 How Does Collaborative Teamwork Support Student Achievement and Self-Efficacy?

Senay Purzer, Purdue University
Dale R. Baker, Arizona State University
Sibel Uysal, Arizona State University

Using the social-cognitive theory as the theoretical framework, this study investigates how collaborative teamwork can support student achievement. First-year engineering student teams participated in this study. Twenty-five students took a pre- and post- self-efficacy survey and their team discussions were video and audio-recorded weekly during a semester. The verbal interactions of the students were coded using a team interaction observation protocol (TIOP). The results indicate that achievement and gain in self-efficacy were significantly correlated ($r=.55$, $p<.01$). However, no direct correlations between achievement and team discourse characteristics were found. There was also a positive correlation between support-orientated discourse and post self-efficacy scores ($r=.43$, $p<.05$). Negative correlations were observed between disruptive discourse behaviors and post self-efficacy scores ($r=-.48$, $p<.05$). Engaging in task-oriented, learning-oriented, or challenge-oriented discourse did not reveal correlations with self-efficacy or achievement. Teams that engaged in support-oriented discourse were able to build communities-of-practice. These findings suggest that the effectiveness of teamwork on individual achievement is mediated by self- efficacy, which can be improved when students engage in support-oriented team discourse.

S12.8.4 Transformation of a Large Lecture Course Using an Inquiry-Based Course for Preservice Teachers as a Model: Clear as a Bell or Lost In Translation?

Emily J. Borda, Western Washington University
Johanna Brown, Western Washington University
Alison K. Dickinson, Longview School District
Lindsey Anderson, Western Washington University
Kory Abercrombie, Western Washington University
Rose Ekins, Western Washington University

Research has shown that inquiry-based science curricula based on constructivist principles are more effective at helping students learn science than lecture-style curricula. However, the structures and expectations of large lecture-style courses present many problems to those seeking to utilize inquiry-based strategies in these courses. Furthermore, many more quality inquiry-based science curricula exist for small courses, often geared toward preservice teachers, than large lecture/lab format courses. We have described a strategy for adapting a curriculum from a chemistry content course for preservice teachers to a large lecture/laboratory course format for students taking chemistry to meet a general education requirement. Our evidence suggests that this adaptation met with improved student learning when compared to the traditional, lecture-style curriculum taught by the same instructor. However, the learning gains in the revised chemistry course were still smaller than those in the science education course upon which it was based. We will discuss some of the more tenacious obstacles we have encountered in the process adaptation and will suggest ways to overcome, or at least diminish the power of, such obstacles such that an effective inquiry- based curriculum can be implemented within these existing structures.

S12.9 Strand 7—SC-Paper Set: Reflection and Co-Teaching in Preservice Teacher Education

S12.9.1 Ten Years of Coteaching in Science Teacher Education: Addressing the Criticisms

Karen Carlisle, Queens University Belfast
Colette Murphy, Queens University Belfast
Jim Beggs, St Marys University College

Coteaching is an approach within pre-service teacher education which addresses the challenge of preparing new science teachers for independent teaching. It involves two or more teachers teaching together, sharing responsibility for meeting the learning needs of students and, at the same time, learning from each other. Ten years of research on coteaching in science teacher education indicate that coteaching impacts positively on the teaching and learning experience of all. Despite the increasing support of coteaching there are a number of criticisms, including coteachers might not be adequately prepared to teach alone; possible ‘enculturation’ into poor teaching practices; and difficult relationships between coteachers may cause problems in the classroom. This paper will address the main criticisms using quantitative and qualitative data collected from our studies and others’ research and practice of coteaching. We will argue that by exploring a wider conception of coteaching, we can collectively resolve some of the issues which remain in terms of enactment and consequences of coteaching, such as transition to independent teaching and relationships between coteachers. By addressing these criticisms it is hoped that this research will help to convince pre-service science teacher educators internationally to implement coteaching as a part of their practical teaching programmes.

S12.9.2 Reflecting on Practice: Using Coplanning for Teacher Development

Kathryn Scantlebury, University of Delaware
Jennifer Gallo-Fox, University of Delaware
Beth Wassell, Rowan University

This study explores the characteristics of different types of coplanning sessions between teachers engaged in coteaching. Drawing on data from a four-year ethnographic study of coteaching as a model for learning to teach, this study explores characteristics of different types of coplanning conversations between coteachers. Data utilized include twenty-two coteachers (10 cooperating teachers and 12 interns) coplanning high school science classes during fifteen-week student teaching experiences. Coplanning sessions could be brainstorming when coteachers co-generated ideas for effective teaching and assessment practices. During reflective cogenerative dialogues coteachers related student learning to previous teaching and then discussed effective approaches to build upon students' knowledge. Managerial cogenerative dialogues focused on lesson and other teaching logistics such as assigning roles, preparing materials, arranging for lab preparation or student access to other resources such as the library or computer labs. These three types of coplanning were cogenerative and reflected a collective responsibility among coteachers. A fourth example is directive cogenerative dialogues where one teacher assumed individual responsibility and assigned duties to the other coteachers. Both groups contributed to the coplanning sessions and developed practice in significant ways. Early in the semester experienced teachers shared expert knowledge and local cultural knowledge, whereas interns asked critical questions, focused conversation, and shared ideas new to the teaching context. As the semester progressed participants had similar contributions.

S12.9.3 Inter-Relations Between and Among Reflection, Use of a Teacher Perspective, Musings/Wonderings, and Explicitly Stated Principles of Practice in the Work of Preservice Teachers

Deborah J. Trumbull, Cornell University
Kimberly N. Fluet, Illinois Institute of Technology
Alfa Choice, Cornell University

We present work tracking the development of science teachers during their pre-service years in order to understand better teacher growth and aspects of teacher education that can contribute to growth. We based our analyses on work completed at key points during the preservice teacher education program. In this work, we looked at reflection, use of a teacher perspective, musings/wonderings, and explicitly stated principles of practice. We have developed profiles of some 20 preservice teachers. These profiles provide an overview of development, but cannot explore the specifics of development. In this paper we will present in-depth data from four teachers, showing the interrelations between different aspects of their developing pedagogy. We chose the students presented here to illustrate a range of trajectories of professional development and to explore the interactions of the aspects of their developing pedagogy. We examine, for example, the extent to which the principles of practice delineated by more reflective individuals differ from principles of practice identified by less reflective preservice teachers. We compare the degree and kinds of musings expressed by preservice teachers who consistently wrote from a teacher perspective to those who generally wrote from a student perspective.

S12.9.4 Assessing the Efficacy of Co-Taught Elementary Science Methods Courses

Peter M. Meyerson, UWO
Stephen Rose, UWO
John Lemberger, UWO
Mike Beeth, UWO

Thirty-seven pre-service education students were involved in a project to assess the efficacy of a co-teaching model of instruction in their science methods course. There were three instructors: an in-service elementary teacher, a university content professor and a university science methods instructor. A mixed methods design was employed. Interview data, survey data, and observations of the classroom were collected and triangulated to create a qualitative case study of the classrooms. A quasi-experimental design was also used to analyze the survey part of the research. This was done by using survey data collected from fifty-eight pre-service students from non co-taught methods sections that served as a control. The case study and the quantitative analysis indicate that while there are benefits to co-taught science methods courses there are also a number of potential barriers that must be addressed for this model to be truly effective.

S12.10 Strand 7—SC-Paper Set: The Role of Content for Preservice Teachers

S12.10.1 How Do We Prepare Student Teachers to Teach Science for Sustainable Development?

Astrid T. Sinnes, Norwegian University of Life Sciences
Birgitte Bjønness, NorwegianUniversity of Life Sciences
Earth Science Faculty's Collaborative Pedagogical Practice and Professional Image in an Introductory Earth Science Teacher Education Course
Yueh-Hsia Chang, National Taiwan Normal University
Chun-Yen Chang, National Taiwan Normal University

2005-2024 has by the United Nations been described as the Decade for Education for Sustainable Development (DESD). One of the goals of DESD is to foster an increased quality of teaching and learning in education for sustainable development. In this paper we present how we try to prepare our student teachers in science education to teach science for sustainable development. The authors of this paper have been responsible for building up a new five year study programme to train science teachers in Norway. In this paper we describe how we use a one week module of this study programme to raise the awareness among the students about the importance of teaching science for sustainable development and the possibility of doing so within the current curriculum. The students were interviewed before and after being exposed to the module. The interviews showed that the module did not change their understanding of the importance on focusing on sustainable development in science education. It did, however, change the way that the student teachers understood their own role as science teachers and their role as agents for change. It also impacted on their thoughts about how sustainable development should be taught in science classes.

S12.10.2 Sound and Sensibility. Science Teacher Students Bridging Phenomena and Concepts

Edvin Ostergaard, University of Life Sciences, Norway
Bo Dahlin, Karlstad University, Sweden

The aim of this paper is to explore how science teacher students conceive of the relation between a particular lifeworld phenomenon and the scientific concepts or models connected to it. For this study we chose the phenomenon of sound. The following research questions are addressed: How do science teacher students express their sense experience of sound? How do science teacher students link these experiences with scientific concepts? What, if any, intermediate notions do they think useful in teaching the scientific concepts? The study is based on interviews and observations of science teacher students participating in a teacher education which applies phenomenological principles to teaching and learning. In the phenomenological approach, the starting point is always a careful description of experienced phenomena, in accordance with Husserl's motto: "return to the things themselves". Results indicated that the scientific pre-understanding of sound dominated students' perceptual experience, making it difficult for them to create a rich perceptual basis for scientific concepts. A phenomenologically oriented science teacher education need to put great emphasis on the development of teachers' sense perceptual abilities, so that they can move freely between the lifeworld of sense experience and the science world of abstract concepts.

S12.10.3 Developing Disciplinary Practices to Support the Pedagogical Practices of Prospective Elementary Teachers

Amy B. Palmeri, Vanderbilt University

This paper examines a carefully designed set of year-long experiences intended to help prospective elementary teachers: (1) come to understand the science subject matter they teach in ways that enable them to see the discipline, content, and ways of thinking through students' eyes; (2) develop ways of uncovering children's ideas and thinking about subject matter as well as the insight to "read" children to determine not just what they think, but how they are thinking; and (3) develop the pedagogical skills and knowledge – a repertoire of ways – to effectively engage students in meaningful disciplinary learning. Analysis of data from videotaped class sessions of the relevant science education courses; instructional intentions, plans and reflections of the teacher educator; prospective teacher's written products from activities completed within the teacher education courses, formal course assignments, and weekly reflections from their field work; and interviews with the prospective teacher's following the implementation of their teaching cycle, suggest that the design choices made in this set of year- long experiences, that of foregrounding the development of content knowledge for teaching through engaging in disciplinary practice has impacted and shaped prospective teachers' pedagogical understandings, decisions, and practices in positive ways.

S12.10.4 Challenges of Connecting Science Learners with Science Content for Secondary Science Teacher Candidates

Hosun Kang, Michigan State University
Charles W. Anderson, Michigan State University

This study explored how secondary science teacher candidates learn to connect science learners with science content while participating in the multiple communities of practice over two years. We examined three secondary science teacher candidates' narratives about science teaching and their teaching practices from senior (4th) year to intern (5th) year. Data were generated from five individual interviews with each teacher candidate at three different stages: 1) end of senior (4th) year, 2) in the middle of the internship (5th year), 3) at the end of the internship, and three classroom observations during their internship. Teacher candidates mostly depended on their own experiences as learners in interpreting student knowledge and constructing their learning model at the senior level, but they started developing coherent models of students' learning associated with content at the intern level. One key to teacher candidates' progress in developing coherent models of content and students, which is crucial for teaching all students, is their moving the sources of model from themselves as learners to careful observations grounded in the classroom as teachers. This progress was difficult and uneven, however, with only one of the three candidates achieving an integrated understanding during his intern year.

S12.11 Strand 8—SC-Paper Set: Classroom Impact

S12.11.1 Professional Development for Elementary Teachers of Science in Thailand: A Holistic Examination

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Sandra K. Abell, University of Missouri-Columbia

This study took place in context of a science professional development (PD) program for elementary teachers in Thailand, and in four classrooms following the PD. The purpose of the study was to investigate the relations of PD outcomes (teacher knowledge and practice) to the professional developers' knowledge for PD and their implementation of PD. We used the PCK model developed by Magnusson, Krajcik, and Borko (1999) as our research framework to examine the professional developers' and teacher participants' knowledge and practice. We found that elementary teachers displayed didactic, activity-driven, and academic rigor orientations and had limited PCK for science teaching. Limits in one type of knowledge resulted in an ineffective use of other components of PCK. The professional developers' orientations, PCK, and time constraints influenced PD design and implementation. It also influenced the ways that professional developers viewed the success of PD. The professional developers' ability to learn from their own PD practice was constrained by their orientations. The holistic nature of this study of an entire PD allowed us to hypothesize about what part(s) of the PD cycle we should perturb to provide more effective PD that supports teachers and ultimately their students in the learning of science.

S12.11.2 Characteristics of Professional Development and Impact of Training on Science Teachers' Classroom Practices

Tunde Owolabi, Lagos State University, Nigeria
Peter A. Okebukola, Lagos State University, Nigeria

In Nigeria, a major constraint against rapid national growth and development is inadequate supply of skilled and well-trained personnel especially science teachers. The study was undertaken to investigate how science teachers in Nigerian schools are equipped with desired knowledge and pedagogic skills through training and to determine the impact of training on classroom practices. This study employed a descriptive survey design and involved 200 randomly selected science teachers. The results showed a generally low level of training received by science teachers. Three of the types of training (improvisation, management of large classes, teaching of difficult concepts) were not received by the respondents. The results further revealed that the science classroom was predominantly teacher directed. Science teaching was found to be predominantly factual (92.32%). Also, problem solving received little attention of science teachers (5.66%), while the experimental approach to science teaching was seldom employed (2.02%). Retraining opportunities for teachers to acquire new knowledge, skills and attitudinal changes needed in a rapidly changing technological world were proposed.

S12.11.3 Threaded Professional Development: A Study of Classroom Impact

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Christine Lotter, University of South Carolina
Robert Feller, University of South Carolina
Al Gates, School District Five of Lexington and Richland Counties

A hallmark of current science education reform involves teaching through inquiry. Both the National Science Education Standards (NRC, 1996) and the Benchmarks for Science Literacy (AAAS, 1993) have been strong advocates of this position. However even with a decade of additional research supporting the effectiveness of these reform-based practices (Schneider, et al., 2002) their wide spread classroom use has not occurred (Songer, Lee, & Kam, 2002; Roehrig & Luft, 2004; Schneider, Krajcik, & Blumenfeld, 2005). The purpose of this study was to investigate the impact of a prototypical professional development program on middle school science teachers' ability to enact pedagogical strategies that align with these science education reform efforts. Data were generated through evaluation of teacher practice using the Reformed Teaching Observation Protocol (RTOP) (Sawada et al., 2002) at three distinct junctures, before, during and after the professional development treatment. Findings demonstrated that RTOP total scores as well as four of the five subscales were statistically significant ($p < .05$) among the three time periods (before, during and after). Changes in RTOP scores illustrated a significant increase in the use of reform-based practices indicating that the teachers were able to successfully transfer the enactment of the reform-based practices into their classrooms.

S12.11.4 The Role of Transformative Professional Development Based on Educative Materials in Affecting Teacher PCK, Classroom Practice, and Student Achievement

Julie Gess-Newsome, Northern Arizona University
Janet Carlson, BSCS
Christopher D. Wilson, BSCS

This study examines the links among teacher knowledge and practice and student achievement. Over two years and across two cohorts, 35 secondary biology teachers implemented one of two biology curriculum materials that were ranked the most educative. During the implementation they received extensive professional development. All units were to be taught during the academic year with fidelity. Pre and post test measures of teacher PCK were analyzed to compare units for which professional development was provided against units without professional development. Classroom videos have been analyzed for fidelity of implementation and evidence of PCK. Student pre and post content knowledge scores were analyzed and correlated to teacher scores. Within-teacher analyses show a positive gain in teacher's concept-specific PCK measures following participation in professional development relevant to that concept. Teacher content knowledge gains were the strongest when a teacher taught the curriculum in their classroom and then participated in professional development on the topic. There was a significant correlation between teacher scores of content knowledge and their scores on a classroom observation protocol related to reform-based teaching. While student gain scores increased in all areas, gains were higher for those topics where the teacher received professional development.

S12.12 Strand 10—SC-Paper Set: Teaching and Assessing Nature of Science

S12.12.1 How Do the High School Biology Textbooks Introduce the Nature of Science?

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Eugene L. Chiappetta, University of Houston

This study was to conduct a content analysis of the first chapter of four high school biology textbooks, using the four themes of the nature of science: (a) science as a body of knowledge, (b) science as a way of thinking, (c) science as a way of investigating, and (d) the interaction of science, technology, and society. The four-theme framework was modified to incorporate descriptors from national-level documents as well as science education research reports. A scoring procedure was used that resulted in good to excellent intercoder agreement with Cohen's kappa (¥ê) ranging from .63 to .96. The findings show that the patterns of presentation of the four themes in the four high school biology textbooks are similar across the different locations of data, text, figures, and assessments while it is diverse by the publishing company. Some reflect a more reasonably balanced treatment of the four themes than others. In addition, a qualitative analysis was undertaken in an attempt to achieve a more comprehensive understanding of the nature of science. This reveals that each textbook describes the nature of science in a considerably different manner. While the emphasis of presentation is remarkably different in each textbook, generally they present several common topics. Most of the high school biology textbooks present a narrow view of scientific methods as well as science, technology, and society.

S12.12.2 Increase of Inquiry Competence: A Longitudinal Large-Scale Assessment of Students' Performance from Grade 5 to 10

Andrea Moeller, Justus-Liebig-University Giessen, Germany
Christiane Grube, Justus-Liebig-University Giessen, Germany
Stefan Hartmann, Justus-Liebig-University Giessen, Germany
Juergen Mayer, Justus-Liebig-University Giessen, Germany

The detailed developmental processes of scientific inquiry competence within the school environment have hitherto been studied only unsystematically. In particular, knowledge of the detailed influence of its four recently empirically proven central skills "formulating questions", "generating hypotheses", "investigation planning", and "interpreting data", on developing scientific inquiry competence has remained meagre to date. Our study shows that over all grades within one school year, inquiry competence increases significantly. Second, regarding the mentioned central skills, the three skills covering question formulating, hypotheses generating as well as investigation planning reveal an increase, whereas the skill to analyze data appears to deteriorate. Across the three German school types (according to different cognitive levels), the type "Hauptschule" shows no increase in inquiry competence. The types "Realschule" and "Gymnasium" provide a significant increase, but do surprisingly not differ. Finally, the biological subject knowledge (i.e. the mark) appears to have no influence on the increase of scientific inquiry competence. We here support the view that inquiry competence can be promoted in the classroom. Our study thus helps providing an assessment tool for teachers to individually promote their students and to increase their central skills.

S12.12.3 Representations of the Processes and Nature of Science: Scientific Inquiry in an Agricultural Science Classroom

Julie R. Grady, Arkansas State University
Erin L. Dolan, Virginia Polytechnic Institute & State University
George Glasson, Virginia Polytechnic Institute & State University

The purpose of this qualitative case study was to explore the practice of scientific inquiry (SI) in an agriscience classroom as students designed and conducted original investigations to characterize the unknown functions of genes that scientists had disabled in Arabidopsis thaliana plants. One class of fifteen students and their teacher participated in the study. Data sources included semi-structured interviews with the teacher, informal conversations with students during class, class observations, students' work, and related documents. Data were analyzed for (1) the teacher's interest in and motivation for implementing SI, (2) the teacher's understandings about SI, (3) students' practice of SI, and (4) representations of nature of science (NOS) during the investigations. Analysis of the data revealed that the teacher had a limited understanding of SI and that she was interested in students engaging in SI because it aligned with the statewide agriscience standards, prepared students for the FFA Agriscience Fair, supported students' learning about the research process and design, and promoted students' understanding of plants and genetics. During the investigations, students were primarily involved with mechanical steps of inquiry rather than analyzing, drawing conclusions, formulating explanations, and communicating findings. The practice of SI implied inadequate and incorrect conceptions of NOS.

S12.12.4 Characteristics of Science Questionnaire (CSQ): Assessing the Nature of Science

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Christian K. Davies, Brockbank Junior High School
David Kent, Independence High School
Adam Mitchell, Diamond Fork Junior High School
Nikki L. Hanegan, Brigham Young University

The Nature of Science (NOS) is difficult to assess. Educators and researchers lack consensus of what NOS is and how to assess it. Teachers have not had a quality assessment tool to measure what students understanding about NOS. Understanding the NOS is important for students to pique their interest in Science. Several assessments have been created. This study looks at the effectiveness of the Characteristics of Science Questionnaire (CSQ) measurement scale for measuring NOS. Development of the CSQ was conducted in two phases. In phase one the questionnaire was given and responses were analyzed. Items on the CSQ were analyzed using a variety of methods to determine difficulty and validity. After the initial analysis several of the items were revised, deleted or replaced. In the second phase the revised CSQ was given and the items were analyzed a second time. The second phase consisted of items that were retained from the first phase with response options being reduced from six to four. All of the items on the second CSQ were determined to provide an acceptable measure of students' understanding of NOS. The CSQ is a valuable tool for high school science teachers to analyze their students' understanding of NOS.

S12.13 Strand 10—SC-Paper Set: Evaluating the Impact of Curriculum Innovations

S12.13.1 The Nature of Science and Physics First: Does Course Sequence Influence Students' Perceptions of the Nature of Science?

James V. Neufell, Jr., Rutgers University

The purpose of this study was to assemble an empirical data set that describes the impact of the Physics First curriculum sequence from the perspective of students' perceptions of nature of science (NOS). Specifically, this study examined two schools, one where Physics First is used and the other where a more traditional science sequence is utilized. Mixed-methods research was employed; therefore, both quantitative and qualitative data inform the study. The results indicate that students who have completed the Physics First sequence do not demonstrate a better understanding of nature of science (NOS) than their counterparts who have completed a more traditional science sequence. The data collected in this study does not support a more refined scientific worldview; a better understanding of the nature of scientific inquiry; or a better understanding of the scientific enterprise by Physics First students. Finally, the evidence collected in this study suggests a 'static' NOS epistemological development between 9th and 11th grade by students in both the Physics First and traditional science sequences. Implications for instruction and recommendations for future research are also discussed.

S12.13.2 Investigating the Impact of Coordinated Reform-Based Physics and Chemistry Curricula on Student Learning: A Quasi-Experiment

Ling L. Liang, La Salle University
Gavin Fulmer, Westat
Richard Clevenstine, Ridley School District
Raymond Howanski, Ridley School District

This study examines the cognitive and affective effects of the coordinated model-centered physics-chemistry curriculum sequence using a quasi-experimental design. Thirteen teachers and 744 students in two Mid-Atlantic high schools participated in the study during the spring and the fall 2007 semesters. Repeated Measures Analyses of Variance with between-subjects factors and hierarchical linear modeling (HLM) were employed for the analyses of the students' pre-/posttest scores on the physics and chemistry concept tests and science attitude surveys. It was found that both the ninth and the twelfth graders enrolled in the modeling physics program achieved statistically significantly greater conceptual understanding of physics than their counterparts in the eleventh/twelfth grade non-modeling physics courses did. Furthermore, it appears that the more frequently that the teacher used the reform-oriented instructional strategies, the lower the effect of low student pretest scores on the posttest scores. In comparison with the physics group, the students' average gain scores on the chemistry concept test in the modeling chemistry classes were also statistically significantly higher than those in the non-modeling classes, but with a much smaller effect size. Neither the modeling physics nor modeling chemistry program demonstrated a positive impact on students' attitudes toward science over a semester-long course.

S12.13.3 Multi-Level Assessment of Scientific Content Knowledge Gains Associated with Socioscientific Issues-Based Instruction

Michelle L Klosterman, University of Florida
Troy D. Sadler, University of Florida

This study explored the impact of a socioscientific (SSI) based curriculum on developing science content knowledge. Using a multi-level assessment design, student content knowledge gains were measured before and after implementation of a 3-week unit on global warming (a prominent SSI) that explored both the relevant science content and the controversy surrounding global warming. Measures of student content knowledge were made using a standards-aligned content knowledge exam (distal assessment) and a curriculum-aligned exam (proximal assessment). Data were collected from 108 students from two schools. Quantitative analysis of the distal assessment indicated that student pre- and post-test scores were statistically significantly different ($F=15.31$, $p <0.001$). Qualitative analyses of student responses from the proximal assessment indicated that students, on average, expressed more accurate, more detailed, and more sophisticated understandings of global warming, the greenhouse effect, and the controversy and challenges associated with these issues following the 3-week unit. Combined results from the proximal and distal assessments explored in this study offer important evidence in supporting the efficacy of using SSI as contexts for science education. In addition to a discussion of the components of a SSI-based curriculum, this study provides support for the use of SSI as a context for learning science content.

S12.13.4 Evaluating the Impact of Science Fair Participation on Student Understanding of the Scientific Process Using a Collaborative Evaluation Communities Approach

Dana Atwood-Blaine, University of Kansas
Doug Huffman, University of Kansas
Bria Klotz, University of Kansas

This paper examines the impact of science fair participation on the attitudes toward science, knowledge of science processes, and skills of science inquiry of students whose teachers were part of a Collaborative Evaluation Community. This is a mixed-method study which combines a qualitative analysis of teacher and student interviews with the results of pre- and post- science fair assessments of science process knowledge and inquiry skills. Through the interviews, students' perceptions of the scientific process became visible and challenges to science achievement became apparent. This research provides confirming evidence that, when certain conditions are met, inquiry-based learning such as the development of a science fair project can have a significant positive effect on students' attitudes toward science and their understanding of the science process.

S12.14 Strand 11—SC-Paper Set: Images across Multiple Contexts

S12.14.1 Cultural Models of "Science Person" In Two Fourth-Grade Reform-Based Science Classrooms: Assessing Equity beyond Knowledge- and Skills-Based Outcomes

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Julie Haun-Frank, The University of North Carolina
Angela W. Webb, The University of North Carolina
Mark Enfield, Elon University
Stacey M. Reavis, The University of North Carolina

The primary justification for reform-based science is that it better promotes students' knowledge and understanding of scientific ideas and abilities to understand and conduct scientific inquiry. However, producing students who know and are able to do science is only part of the solution in achieving scientific literacy for all students. Evaluating equity means asking questions about science education's effectiveness beyond knowledge- and skill-based outcome measures. For example, what does it mean to be scientific in reform-based classrooms? Who gets to be scientific? What are the processes by which "promising" and "struggling" science students get defined? In this comparative ethnography of two fourth-grade reform-based classrooms, we explore the promoted cultural models of science person by examining the normative scientific practices to which students were held accountable and the accessibility of those cultural models for a broad range of students. Based on the two teachers' similar commitments to reform-based science, we expected that the meaning of "being scientific" in each class would be similarly accessible. That was not the case. We provide thick descriptions of how the different cultural models emerged from very similar normative scientific practices, how the cultural models were differently accessible in each classroom, and explanations for why.

S12.14.2 Students' Embodied Images of Science and Scientists: Sculpted by Culture? An International Study

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Soonhye Park, University of Iowa
Deniz Peker, Middle Eastern University
Bapin Ding, Capital Normal University
Jeong-Yoon Jang, University of Iowa

This cross cultural research study involved children from India, South Korea, Turkey, China and the United States. In this study we conducted a cross cultural analysis of children's' perceptions regarding scientists, the similarities and differences between their stereotypic perceptions of scientists and the cultural factors contributing to these. The participant pool included students from grades three, seven and nine (120 per grade, per country) who were administered a modified Draw-A-Scientist-Test (Chambers, 1983). Randomly chosen students were also interviewed using a semi-structured interview protocol. A one-way ANOVA was performed to test for differences among the three countries. Results revealed commonalities and differences in the stereotypic perceptions regarding scientists children exhibited. Fewer stereotypes were exhibited at the lower grade than at the higher grades. A majority of the participants from Asia drew male scientists; several students especially at the lower grade identifying their scientist to be Edison, Bell, Einstein and Newton. Students were more readily able to name one of the above scientists than a scientist from their own country. Cultural factors such as the public attitude towards science and technology, parental/ familial and teacher involvement in students' education, and the availability of role models in science related fields is discussed.

S12.14.3 Students' Presuppositions of What the World is Like and their Interest in Choosing Science

Britt Lindahl, Kristianstad University Sweden
Lena Hansson, Kristianstad University Sweden

This paper is about the relationship between students' choice/non-choice of a science profile in upper secondary school and students' presuppositions of what the world is like, particularly how similar/different these presuppositions are from the ones students associate with science. The students in this study are participants in a longitudinal research project. The data consist of responses to a questionnaire (N = 47) and to interviews (N = 26). The results show that students frequently associate the ideology of scientism with science, but the majority does not personally agree with that ideology. Students often present different positions when expressing their own view of the world compared with their view of science. The number of conflicts for individual students ranged from zero to more than 20. The study shows that for students who have a high ability in science, those who have chosen science- intense programs in upper secondary school have less conflicts than the students who have studied other kinds of programs. This indicates that students who embrace a worldview different from the one they associate with science tend to exclude themselves from science/technology programs in upper secondary school. Implications for science teaching and for further research are discussed.

S12.14.4 Learning without Interest: Science Learning in Korea

Nam-Hwa Kang, Oregon State University
Miyoung Hong, Korea Institute for Curriculum and Evaluation

The purpose of this study was to find a way to understand Korean students' low interest in science learning. We identified typical practices of science teaching in Korean classrooms through video analysis and interviews. Using a survey, students' perceptions of science learning environments were assessed. We found that a teaching approach in which fundamental ideas were repeatedly presented in a one-way communication format was prevalent. Developing scientific thinking skills were rarely encouraged in most of the teachers' classrooms due to the constraints teachers had. Students' perceptions of their learning environment were consistent with the findings. While the findings cannot be generalized we gain some insight into the possible explanation for the low interest Korean students have in science learning while still achieving high scores in international assessments. The repeated presentation of fundamental concepts may help students understand the basic concepts of science, and yet the teaching approach rarely promotes students' own thinking through which they could have enjoyed learning science.

S12.15 Strand 11—Related Paper Set: Culturally Responsive Science Teaching and Learning in a Multicultural Elementary School: A Researcher-Practitioner Design Collaboration

S12.15.1 Valuing Prior Understandings: Young People's Ideas about Health and Nutrition in a Multicultural Community

Suzanne Reeve, University of Washington

Though health and science are often taught separately in schools, using health as a context for science education makes good academic, societal, and economic sense. A basic step towards designing health-based science curriculum, however, is to first investigate how young people develop ideas about personal health and how they choose to act on them. The research questions we investigated are (1) How do children and families come to understand personal health, including related nutritional topics, in a multicultural community? (2) What are the implications of these findings for science education? We conducted open-ended, ethnographic interviews about health and nutrition with thirteen children from an urban, multicultural community. Interview questions addressed health maintenance, illness causation, and the functions of food and eating. We also elicited unanswered questions the children have about these topics. Participants' responses yielded many common themes, but also idiosyncratic ideas. Children also frequently connected their answers to everyday experiences, and expressed questions about health and food that indicate an interest in underlying mechanisms, not just simple behavioral imperatives. These findings suggest opportunities for science educators to incorporate more health-based principles in their classrooms.

S12.15.2 Micros and Me: Connecting Repertoires of Practice between Home and School

Carrie Tzou, University of Washington
Philip Bell, University of Washington

For many students, learning science in school is like learning another culture (Aikenhead, 1996). Students may not see themselves or their

ways of knowing reflected in the practices of science in school. We argue for the need to diversify the images of science that students encounter in school so they may come to see themselves as people who can do science, based on images that reflect actual scientific practices and their own culturally-based ways of knowing. This paper describes a design effort aimed at constructing learning pathways between students' culturally-based "repertoires of practice" (Gutierrez & Rogoff, 2003) around health and school science. We ask two questions: (1) how can we elicit and make visible students' everyday expertise around health in science instruction? (2) how can we deeply connect this expertise to authentic scientific practices? In the unit, we use a technique that we call "self-documentation" to elicit students' repertoires of practice and leverage them in classroom science instruction. We report on findings that show how the self-documentation technique shows promise in both eliciting and complicating culturally-based practices in classroom instruction.

S12.15.3 The Scientific Practice of Observation across Social Settings:

Heather Zimmerman, Pennsylvania State University

This paper is an inquiry into how a deep understanding of children's scientific practices across social settings can be used to inform curricular design. The focus is on the practice of observation and the consequent knowledge-building that children conduct at home, in school, and through community institutions and cultural pursuits. First, an understanding of scientific practices across settings was developed through an ethnographic study (n=128). Findings from the cross-setting ethnographic work were then applied to the design of an educational intervention in two fifth grade classrooms (n=34) to adapt curriculum based on what the children know and need to know about scientific practices. The intervention was created to tie the intellectual observing work that the students did to the intellectual work of building explanations within a disciplinary body of knowledge in biology. Ethnographic findings include that observational practices were used across activities and settings in which elementary and middle school children participate. Design based research findings include that, through designing scaffolds that connect observations to data to evidence to answer biological questions, students can see the observational work they do as part of a larger knowledge-building process.

S12.15.4 Design Collaborations as Professional Development: Orienting Teachers to Their Students' Everyday Expertise

Philip Bell, University of Washington
Carrie Tzou, University of Washington
Patricia Koeller, Seattle School District
Elyse Litvack, Seattle School District
Marcia Ventura, Seattle School District

Very few professional development programs are designed to orient teachers to students' everyday expertise in science. In this paper, we will present findings from a curriculum design effort in which the design collaboration itself was a significant professional development event for both the practitioners and the university researchers involved. The purpose of the collaboration was to elicit and meaningfully leverage children's expertise around science and health in the context of a curriculum connecting health and microbiology. We will discuss how, through this collaboration and two iterations of implementing the curriculum, teachers became more deeply oriented to how their students' everyday expertise related to science instruction, and the university researchers became more aware of the challenges of architecting learning pathways that connect students' out of school expertise with science instruction. The question we ask here is: how can design collaborations between practitioners and university researchers act as professional development opportunities to promote teacher and researcher learning?

S12.16 Strand 14—Strand Invited Symposium: Eco-Justice in and through Science Education: A Community Discussion

Steve Alsop, York University
Larry Bencze, University of Toronto
Michael P. Mueller, University of Georgia – Athens
Deborah Tippins, University of Georgia – Athens

Ecojustice embodies the commitments of both human justice and ecological sustainability. Through globalization and a Western hyper-consumer cultural bias, we see the demise of diverse languages, cultures, traditions and social practices as well as the exploitation and degradation of the environment necessary for our survival. Coordinators for Strand 14: Environmental Education invite you to join us in presentations and discussions to consider the "Grand Challenges and Great Opportunities in Science Education" as it relates to an ecojustice pedagogy. We will explore science education epistemic responsibility to include the responsibility to know and act, connections between education for sustainable development (ESD) and science education, and methods of preparing science teachers through a

Community-Ecology-Education (CEE) framework. In addition, research ideas and implications will be discussed. Presenters will give an overview of their work, theoretical frameworks, and implications for science education. Following the presentations, open discussion will take place. Our goals for this symposium are to discuss past, current and future ideas, implications and opportunities for scholarly and practical work in this area.

S12.17 Strand 15—SC-Paper Set: Policy in Action: Transition from High School to College

S12.17.1 Student Persistence in Science and Mathematics from High School through College

Adam V. Maltese, Indiana University

The focus of this analysis was to learn more about how students progress through the STEM pipeline from 8th grade through college Using data from 4700 students, the descriptive analysis demonstrated that most students who earned a major in STEM completed at least three or four years of STEM courses during high school, and a greater proportion of those who completed STEM majors enrolled in advanced mathematics and science courses during high school. The second part of this analysis involved logistic regression modeling to investigate relationships between selected predictors and the outcome of completing a STEM major. The most significant finding was that measures of student interest and engagement in science and mathematics were significant in predicting completion of a STEM degree, above and beyond the effects of course enrollment and performance. The results also support previous research that showed demographic variables have little effect on persistence once the sample is limited to those who have the ability and desire to complete a degree. A final analysis, comparing descriptive statistics for students who switched into and out of the STEM pipeline during high school, suggested that attitudes toward mathematics and science play a major role in choices regarding pipeline persistence.

S12.17.2 The Development and Validation of the Teachers Goals for Science Education Scale: Moving Toward Understanding Teachers Interpretation of Policy

Todd L. Hutner, Lyndon B. Johnson High School Austin, TX
Sherry A. Southerland, The Florida State University
Victor Sampson, The Florida State University

Some researchers describe three possibly rival goals for science education: the production of future citizens, laborers, or scientists, respectively. An examination of the history of science education indicates that these goals have been present for the past century. The current reform movement, led by the National Research Council and American Association for the Advancement of Science arises from the desire to produce successful future citizens, and places an emphasis on equity and science for all. This may be at odds with the beliefs of teachers whom support the production of future scientists or laborers. In an attempt to further understand these goals, a Likert style scale was developed along 4 subscales to illuminate teacher beliefs about each goal, as well as their beliefs about the current reform movement in science education. Steps were undertaken to insure a reliable and valid instrument. Implications of this research may help to partially explain the lack of implementation of the current reforms. The researchers hope this will illuminate the tenuous connection between science teaching at the classroom level and policy decisions at the state and national level, particularly where the goals of policy makers differ from the goals of teachers.

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