Science Denial and Disinformation: Teaching and Learning in Uncertain Times

NARST Virtual Event
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Guest Eds. Doug Lombardi and K.C. Busch

JRST Special Issue

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Motivation for the Special Issue

- Contemporary challenges—such as climate change, food, energy and water security, and deadly virus transmission—call for all people to think critically and scientifically.
- While many societal challenges are seriously impacting local, regional and global communities, an increasing availability of information has contributed to what many call a “Post-Truth Era,” where emotions and personal beliefs override scientifically validated evidence and explanations, and create an atmosphere of distrust and discord (McIntyre, 2018).
- Scientific thinking, learning, and teaching are severely tasked by this treacherous situation of science denial and disinformation (Allchin, 2022; Osborne et al., 2022; Sinatra & Hofer, 2021).
- In response, the Journal of Research in Science Teaching (JRST) issued a call for papers for a Special Issue focusing on research related to learning and teaching in times of science denial and disinformation.

Editorial: Effective strategies for learning and teaching in times of science denial and disinformation

1. Acknowledge the social nature of knowledge and build epistemic networks
2. Address mis- and disinformation directly
3. Build Nature of Science (NOS) knowledge
4. Ensure topics are socially relevant and meaningful
5. Model critical evaluation of how power and privilege influence information
6. Offer multiple sources of information
7. Offer opportunities for students to reflect
8. Provide explicit instruction on how to evaluate information
9. Support the development of scientific reasoning skills
10. Support perspective-taking

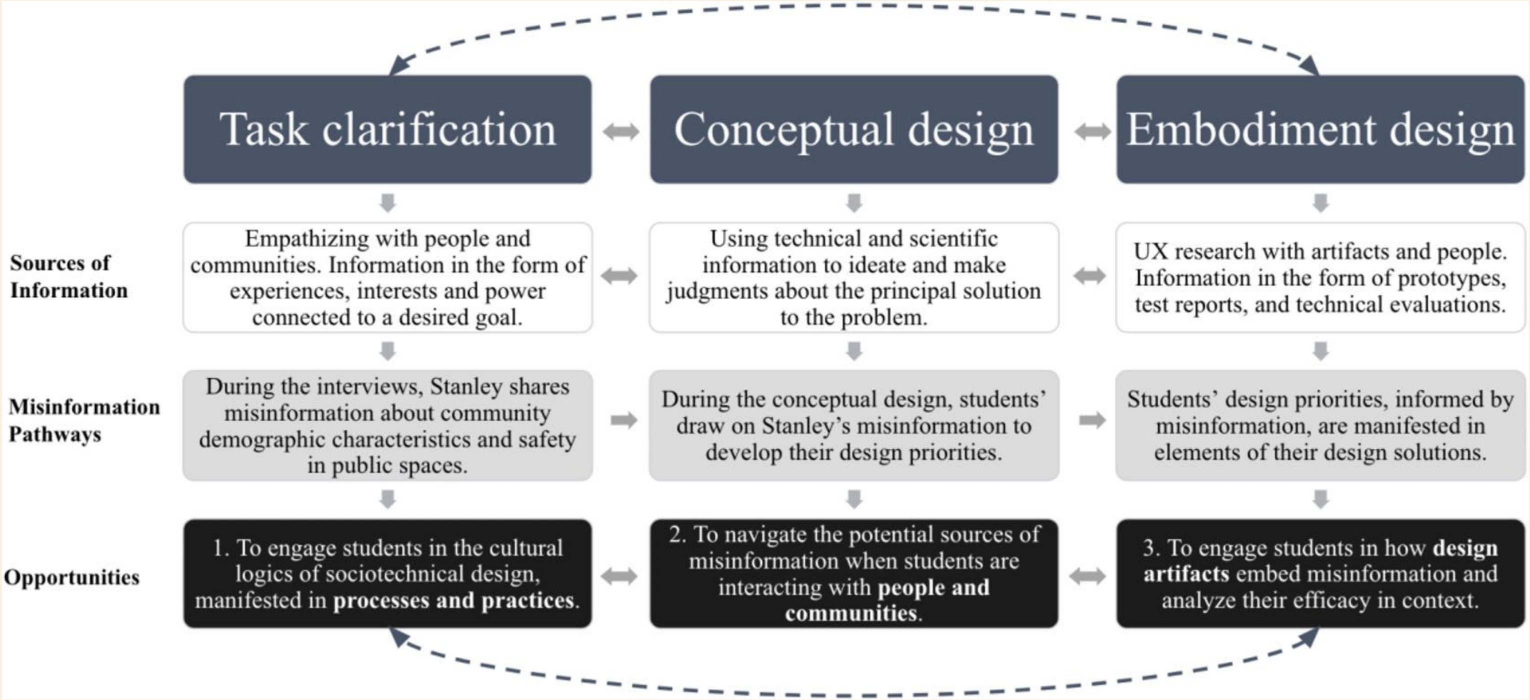
Busch & Lombardi, 2025

JRST Special Issue Articles and Authors

Paper Title (in alphabetical order)	Author Names
Addressing media and information-literacy in engineering: Learning to design technologies in the era of science denial and disinformation	Pérez, Greses; Henderson, Trevion; Wendell, Kristen
Conceptual Contamination: Investigating the Impact of Misinformation on Conceptual Change and Inoculation Strategies	Danielson, Robert; Heddy, Benjamin; Ramazan, Onur; Jin, Gan; Gill, Kanvarbir; Barry, Danielle
Epistemic networks and the social nature of public engagement with science	Feinstein, Noah; Baram-Tsabari, Ayelet
It's not just a science thing: Educating future STEM professionals through mis/disinformation responsive instruction	Herman, Benjamin; Clough, Michael; Rao, Asha; Poor, Sarah; Kidd, Aaron; De Jesús, Daniel De Jesús
Learning to Evaluate Sources of Science (Mis)information on the Internet: Assessing Students' Scientific Online Reasoning	Pimentel, Daniel
Patterns of Belief and Trust in Climate Change Information	Johnson, Victoria; Butterfuss, Reese; Harsch, Rina; Kendeou, Panayiota
People who have more science education rely less on misinformation, even if they don't necessarily follow the health recommendations	Rozenblum, Yael; Dalyot, Keren; Baram-Tsabari, Ayelet
Preparing Students for a Post-truth World: Constructs for Navigating Science-Related Issues	Kruse, Jerrid; Voss, Sarah; Easter, Jaclyn; Kent-Schneider, Isaiah; Menke, Lucas; Owens, David; Roberts, Kean; Woodward, Lindsay
Stop the Spread: Empowering Students to Address Misinformation through Community-Engaged, Interdisciplinary Science Communication Training	Cagle, Shelby; Anderson, Ashley; Kelp, Nicole
Students' awareness and conceptions of science related communication mechanisms on social media	Kresin, Soraya; Büssing, Alexander Georg; Kremer, Kerstin

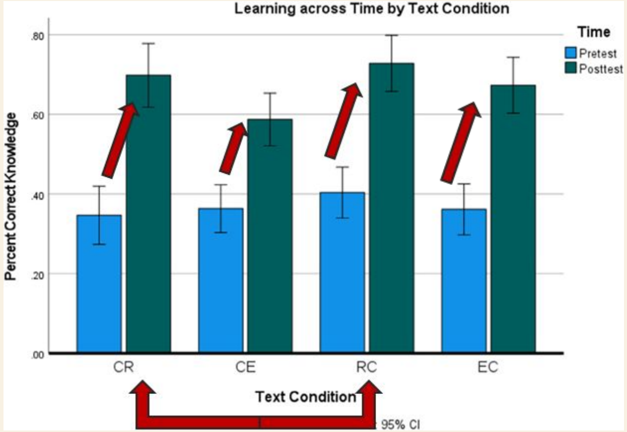
Addressing media and information-literacy in engineering: Learning to design technologies in the era of science denial and disinformation

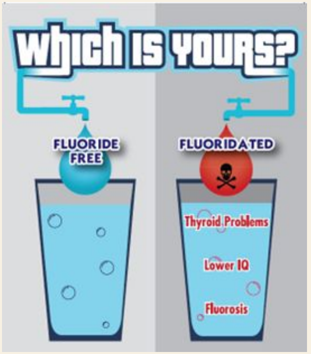
Greses Pérez, Trevion Henderson, Kristen Wendell



Conceptual Contamination: Investigating the Impact of Misinformation on Conceptual Change and Inoculation Strategies

Robert Danielson, Benjamin Heddy, Onur Ramazan, Gan Jin, Kanvarbir Gill, Danielle Barry



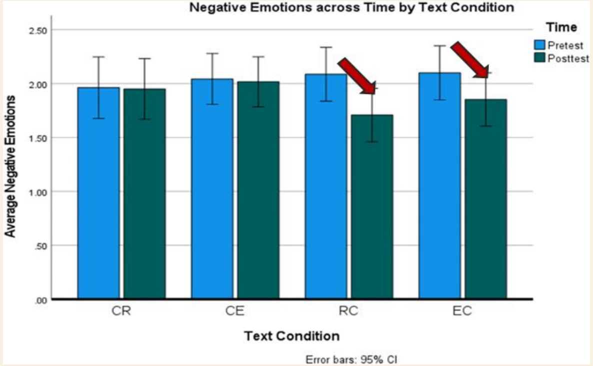


Introduction

Given Alexander et al.'s claim that the learning system does not discriminate for content, we wanted to see the relative influence of seeing a "contamination" text either before or after seeing a traditional expository or refutational text. We were also interested in the emotions and attitudes.

Findings:

1. **Order matters** – all things being equal, getting "out in front" of misconceptions is a better strategy than playing "catch up", especially with a traditional expository text.
2. **Approach matters** – regardless of order, refutational approaches outperformed the traditional approach to apply knowledge after exposure.
3. **Emotions matter** – while major emotional shifts were not detected in this study, changes in emotion, more so than changes in knowledge, predicted changes in attitudes.
4. Students still learned – regardless of the combinations, students still learned a significant amount of true information around fluoridated water.



Epistemic networks and the social nature of public engagement with science

Noah Feinstein, Ayelet Baram-Tsabari

- Public engagement with science unfolds over time, serves particular social purposes, and relies on social interaction through relationships of differing quality and type.
- “The social nature of public engagement with science is neither inherently good nor inherently bad. It is simply inevitable, and science education should be designed with this reality in mind.”
- “...the blending of scientific and non-scientific knowledge in context-specific ways is essential to public engagement with science. It is not noise in the system to be filtered out, but rather a reality to be anticipated.”
- **How might science education help people to use epistemic networks skillfully?**

Nobody knows everything! Epistemic division of labor is important in science – and in public engagement with science, too. In this context, students should learn to:

1. **Understand how collective sensemaking can make decisions more robust and effective - as well as being aware of common mistakes.** Your epistemic network limits your access to information and what questions you can ask or answer.
2. **Evaluate the strengths and weaknesses of an epistemic network for answering different sorts of questions.** Who is part of your thinking team? Different people are trustworthy sources about different things and help in different ways.
3. **Use their networks effectively by matching resources with questions** - and knowing when you don’t have the right team for the job.
4. **Articulating what is missing and adding to or pruning networks** in response to experience, over time.

It's not just a science thing: Educating future STEM professionals through mis/disinformation responsive instruction

Benjamin Herman, Michael Clough, Asha Rao, Sarah Poor, Aaron Kidd, Daniel De Jesús

Mixed-methods study on 506 students in TX University Intro for Biology Majors' Course in spring 2021 during COVID-19 vaccine roll out.

Pandemic responsive instruction:

- COVID-19 science, viral biology/vaccines
- Contextually relevant NOS
- Mis/disinformation
- Responsive to students' identities/backgrounds

Outcomes:

Students' NOS views and vaccine acceptance/conspiracy resistance significantly improved (med-large effect).

Associated with improved vaccine acceptance views:

- Race/ethnicity
- Political orientation
- Changes in NOS/vaccine conspiracy views

Implications:

- Deficit models for science instruction are ineffective.
- Teachers must recognize and shape instruction to how sociocultural variables and media will impact how students conceptualize and respond to SSI.
- Students should analyze how personal biases and mis/disinformation influence how they engage SSI.

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Learning to Evaluate Sources of Science (Mis)information on the Internet: Assessing Students' Scientific Online Reasoning - Daniel Pimentel

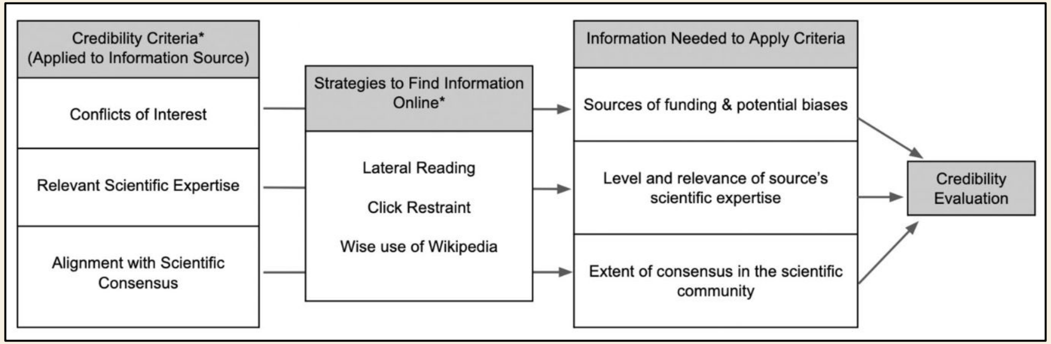


TABLE 5 Overall student performance on written evaluation tasks ($n = 43$).

Task	Max. Score	Pre-task mean (IQR)	Post-task mean (IQR)	Z[a]	Effect size[b]
Conflicts of interest	3	1.30 (0)	2 (2)	−3.67***	0.56
Relevant expertise	3	1.21 (0)	1.95 (2)	−4.50***	0.69
Alignment with consensus	3	1.26 (0)	2.09 (2)	−4.07***	0.62

[a]Two-tailed Wilcoxon signed-rank tests.
[b]Effect size determined by taking the absolute value of the Z statistic divided by square root of the sample size.
***$p < 0.001$.

Increased use of online reasoning strategies on post-tasks and think-alouds

Design Principles

1. Incorporate authentic, real-world examples from the open internet that vary in credibility
2. Explicitly inform students that sources in the materials vary in credibility
3. Prompt discussions about how social-institutional processes contribute to the production of scientific information
4. Support student use of credibility criteria and reliable strategies for evaluating scientific information online
5. Support students in reasoning across multiple sources from the open internet

Patterns of Belief and Trust in Climate Change Information

Victoria Johnson, Reese Butterfuss, Rina Harsch, Panayiota Kendeou

How do different *sources of scientific information* (conservative vs. liberal vs. scientific) interact with individuals' *political ideologies* and *epistemic beliefs* to influence ***source trust*** and ***belief*** in climate change claims?

Source partisanship, individuals' political ideology, and individuals' epistemic beliefs interactively influence trust in sources and belief in climate change claims

Online experiment (n = 559) where US adults viewed 24 statements from conservative, liberal, and scientific sources

- ➢ Individual political leanings and epistemic beliefs influence uptake of scientific claims and science denial
- ➢ Certain epistemic profiles can promote deference to scientific sources
- ➢ Many individuals don't differentiate between sources of scientific information

People who have more science education rely less on misinformation, even if they don't necessarily follow the health recommendations

Yael Rozenblum, Keren Dalyot, Ayelet Baram-Tsabari

How **abilities** and personal **relevance** relate to reliance on misinformation in COVID-19-related decision-making?

An online survey (N = 500) measures participants' science education, knowledge, misinformation detection strategies, relevance, and decision-making processes related to two COVID-19 dilemmas

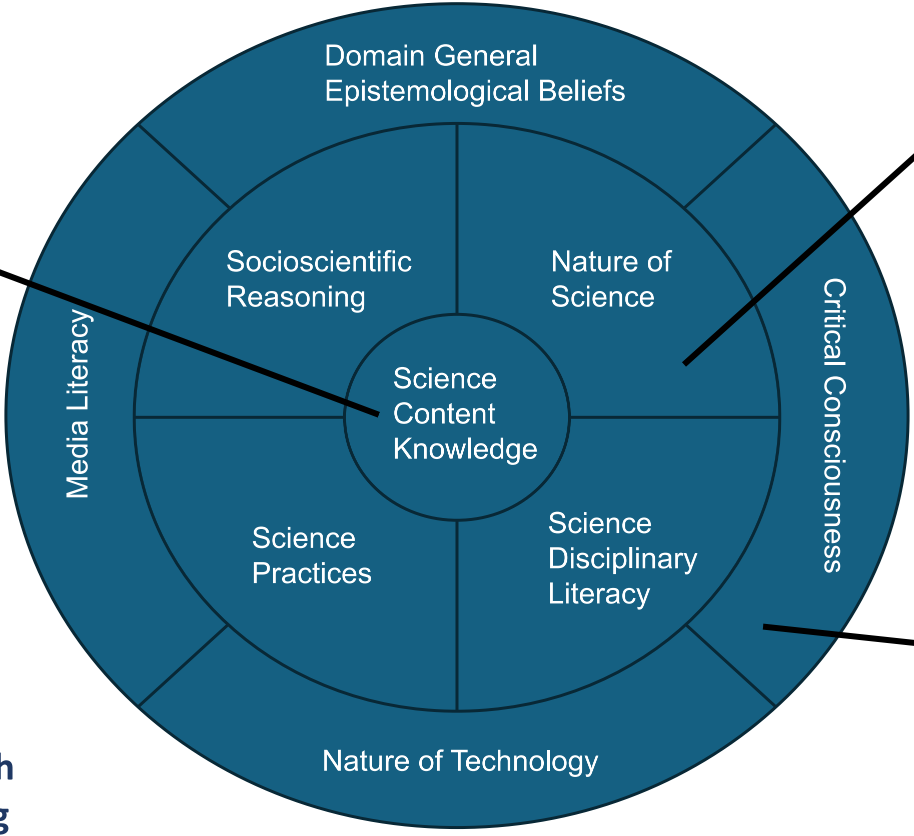
(1) **Reliance on misinformation** was associated with rejecting social distancing and with superficial information processing
(2) **Personal relevance** was associated with rejecting expert recommendations, but also with deeper information processing and less reliance on misinformation
(3) **Science education** was associated with deeper information processing and reduced reliance on misinformation

Science education and **personal relevance** do not guarantee an acceptance of experts' recommendations, but they increase individuals' cognitive engagement, leading to deeper information processing and less reliance on misinformation

Preparing Students for the Modern Information Landscape

Jerrid Kruse, Sarah Voss, Jaclyn Easter, Isaiah Kent-Schneider, Lucas Menke, David Owens, Kean Roberts, Lindsay Woodward

Inner Ring: Topic-specific science content knowledge (e.g., knowledge about acids and bases) pertinent to particular science-technology-society issues



Middle Ring: Domain specific constructs that apply broadly within the domain of science

Outer Ring: Domain general constructs that apply to issues of mis/disinformation and the modern information landscape even beyond science

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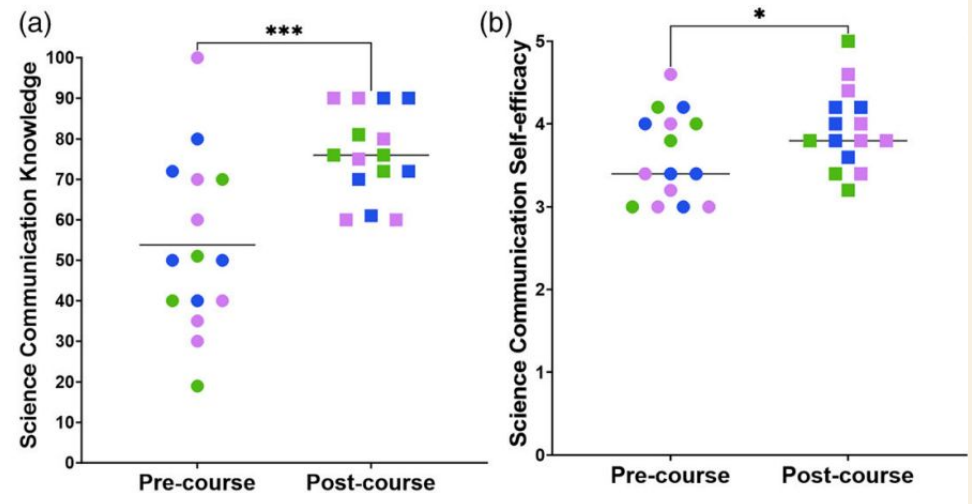
Stop the Spread: Empowering Students to Address Misinformation through Community-Engaged, Interdisciplinary Science Communication Training

Shelby Cagle, Ashley Anderson, Nicole Kelp

<u>What</u>: Semester-long interdisciplinary (STEM, journalism, & public health) SciComm grad course (n=15); based in TPB
<u>Methods</u>: qual and quant data (assignments, interviews pre & post)



Course participation increased misinfo correction knowledge, self-efficacy, and inclusive approaches

"…science is something that I really enjoy and it's helped me form an understanding of the world, and I really wanna help other people be able to make those same—not the same exact conclusions, but to be able to understand the world better and yeah, understand their relationship with the world." (STEM, post-course)

"Different cultural ways of knowing things doesn't necessarily mean that they don't know about science or things like the way that society operates. But they have different ways of understanding it." (journalism, post-course)

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