JRST
Journal of Research in Science Teaching
Research Brief
VOL.62 NO. 2, PP.391- 425 (2025)

The IPM Cycle: A Tool for Promoting Students' Engagement in Modeling

Anna Garrido & Digna Couso

OVERVIEW: This study extends prior modeling-based sequences to propose the IPM (Instruction Performance Modeling) cycle, facilitating the design and implementation of instructional sequences that engage students in rich and productive modeling practices.

AUDIENCE: Administrators (K-12), District science coordinators, Doctoral advisors, Formal educators, Instructional designers, K-12 science teachers, Professional development providers, Researchers/Researcher supervisors, Secondary science teachers, Teacher educators, Biology educators, Chemistry educators, Physics educators, Earth science educators, STEM educators, Elementary science teachers

KEY POINTS

- There is a recognized polysemy in the term modeling and great diversity of proposals for promoting modeling in the science classroom.
- The IPM cycle is a practical, problem-focused, condensing tool that addresses three problematic issues identified in previous modeling-based cycles.
- The IPM cycle has evidenced its usefulness for teacher educators and instructional designers.
- The sequential phases of the IPM cycle foster students' rich and meaningful modeling activity that is far more intricate than initially anticipated and is able to facilitate the titanic process of transformation of students' ideas.

INTRODUCTION: The importance of models and modeling in science education is well-recognized in the literature despite its polysemy, being referred to as an expected student performance, an instructional strategy to promote such performance, or both. Aiming to shed light into the multiple complexities associated with modeling, this paper draws upon previous contributions to present the Instruction Performance Modeling (IPM) cycle, which is a practical tool for designing modeling-based sequences. The paper analyzes the modeling performance exhibited by pre-service teachers involved in instruction guided by the IPM cycle, by applying discourse analysis to their multimodal productions and discussions on the topic of flotation.

FINDINGS: The main findings show rich, meaningful, and productive modeling practices occurring in instructional scenarios guided by the IPM cycle. In particular, they reveal that students' modeling performance, while exhibiting certain patterns such as the Introductory pattern or the Evaluation-Revision one, predominantly manifests as a disorganized sequence of modeling practices. This result is consistent with certain precedents in the modeling literature but contrasts with the expected outcomes of well-established approaches like GEM.

The Introductory pattern appears to function as a starting point in many conversations, in which students sequentially engage in using and expressing their models and then evaluating and revising them. Conversely, the Evaluation-Revision pattern shows an iterative engagement in evaluating and revising their models. This back-and-forth pattern is not necessarily interpreted as something negative, as by doing so, students are having a rich discursive activity and enhancing their scientific ideas, being close to what scientists do.

TAKEAWAYS: There are three important takeaways from this study:

- Modeling instruction guided using the IPM cycle, both at the design and implementation levels, leads to productive modeling practices within students.
- The implementation of the IPM cycle in the science classroom includes six instructional phases that entail specific teaching strategies aiming to promote particular students' modeling practices.
- Actual students' modeling performance is more complex than expected and does not necessarily follow the canonical sequence of Generation-Evaluation-Modification.

Full Title: The IPM Cycle: An Instructional Tool for Promoting Students' Engagement in Modeling Practices and the Construction of Models