

used their ideas and blended them with ideas of the peers to reach a collective understanding of a concept. They also felt their scientific writing improved. Due to their active roles in performing the labs and interpreting the results, students were better able to write experimental procedures, create data tables, and graphs from collected data, and then write a conclusion that discussed what they learned, why it happened, and what they would like to do next. Although unsolicited and anecdotal, these positive student comments motivate future systematic studies of modeling instruction's impacts on both content mastery and students' mindsets.

CONCLUSIONS

Several outcomes of this study support the further refinement, implementation, and assessment of the modeling instruction's efficacy. Over 60% of students demonstrated mastery of the two objectives assessed here, which range from lower-order thinking skills (know and understand) to higher-order skills (explain/predict, develop guiding principles, and expression of concepts with multiple models). In addition, our data demonstrate some of the ways Modeling Instruction informs teaching practices by giving students the tools and vocabulary to articulate conceptual misconceptions. Semester-long trends in exam scores suggest that Modeling Instruction facilitates content mastery and retention more effectively than traditional instruction. Finally, anecdotal evidence, particularly insights into student mindset, shows that modeling instruction impacts the ways students think about their own learning. Students learn that is okay to fail and that they can construct answers from data – two critically important mindsets for life-long learners.

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