Science and Engineering Practices in Secondary Science

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Master of Science in Science Education

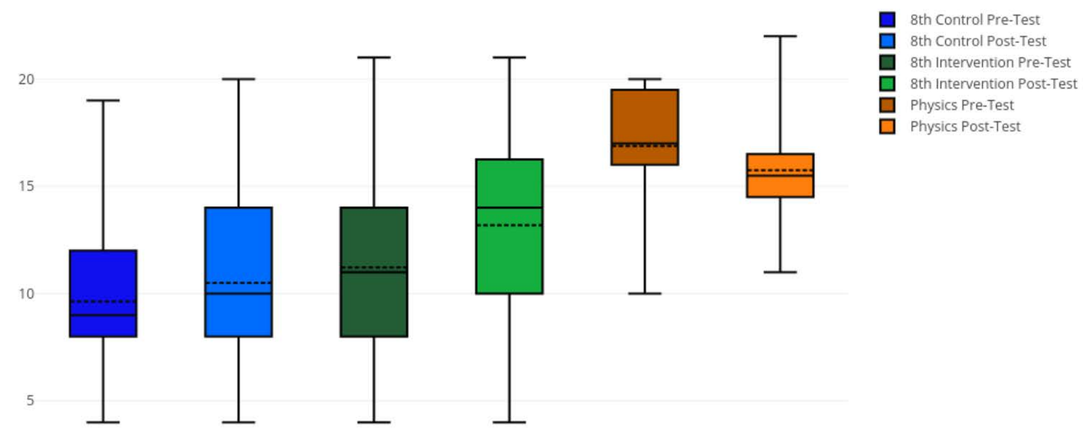
Background:

Throughout my teaching career, I have always felt strongly that students should be taking a lead role in designing and making sense of experiments, and to learn by reasoning with one another. However, I have struggled with finding authentic ways of assessing these skills, and as a result some of my highest priorities in teaching are not articulated as well as they should be, nor are they factored significantly in to the students' grades. In this research, I strove to answer the following questions:

- **Can the NGSS Science Practice Standards of designing and carrying out investigations and engaging in argument from evidence be assessed effectively with rubrics?**
- **Does more careful assessment of these practice standards improve student performance in these areas?**
- **Does more careful assessment of these practice standards improve student performance in relevant standardized test questions?**

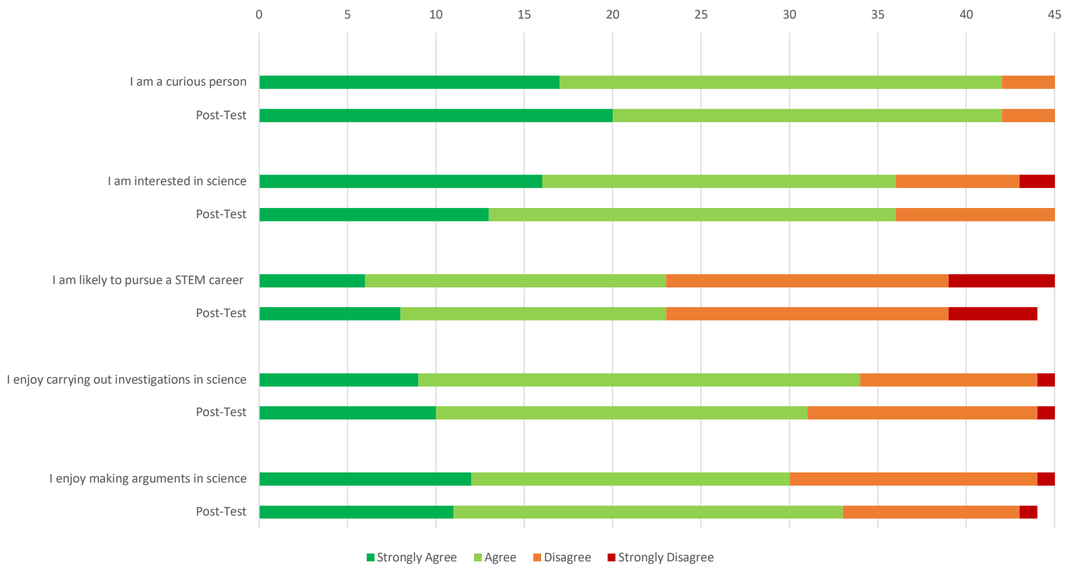
This research was carried out in two sections of eighth-grade grade science, and a section of high school physics. A control group was established using two additional sections of eighth-grade students taught by a colleague. I work in a public middle/high school that serves Telluride and the surrounding area in southwestern Colorado. There are about 900 students in the district, 83 students were involved in my study, with 45 receiving the treatment.

Data and Results



The eighth-grade treatment group saw a normalized gain of 15.4%, while the eighth-grade treatment group saw gains of six percent. The group of eight physics students did slightly worse on the post test, as seen in the figure above. Overall, changes in student perceptions of science over the course of the treatment were small, shown in the figure below. No significant correlations were detected between performance or gains on Lawson's Classroom Test of Scientific Reasoning and changes in responses to the survey questions.

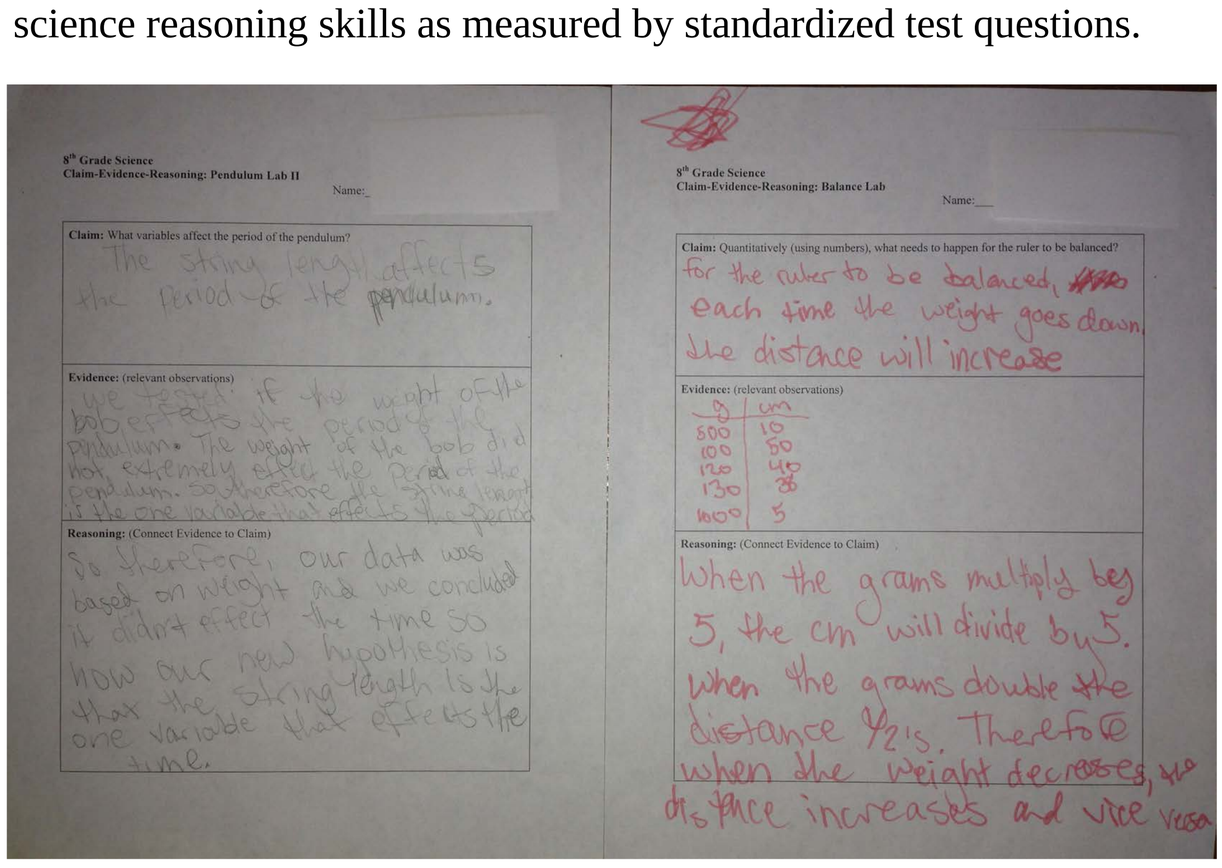
In post-treatment interviews, strong majorities of students reported that the Investigations Rubric and Claim-Evidence Reasoning scaffold were helpful in communicating expectations for these tasks.



Methodology:

In this study, two sections of middle school science students and one section of high school physics students received more explicit instruction around my targeted NGSS practice standards. Rubrics were developed to assess student performance while carrying out investigations, and the Claim-Evidence-Reasoning structure was used to scaffold arguments. Rubrics were shared with students, who were also asked to self- and peer-assess using the same rubrics. Data from the rubrics was kept, and compared with survey data that asked students about their attitudes toward these skills and science generally. The rubrics also served as formative assessments, and concepts were re-taught as needed when patterns of misunderstanding could be discerned from the data.

Lawson's Classroom Test of Scientific Reasoning was administered before and after the intervention to gauge whether the intervention had any effect on students' laboratory reasoning skills. Students also completed a survey before and after the intervention, and a subgroup of students were interviewed about their experiences after the intervention was complete. Data was analyzed to see if any improvement in student performance in these two practices could be discerned in laboratory activities and written arguments, whether there was an effect on student attitudes towards these practices or science generally, and whether there was improvement on science reasoning skills as measured by standardized test questions.



Conclusion and Value

Though the shifts in the data were small, I feel the changes I made to my practice over the course of the study were positive and helpful to students. It was difficult to measure the shifts in my own approach to lab activities, but these changes were an important clarification for me as a science educator. For example, when restructuring an activity around an argument that I wanted students to construct, I found myself working hard to clarify the question I wanted the students to make a claim on, and creating opportunities for them to design investigations that would provide useful evidence to back up that claim. This shift felt like it provided a more authentic scientific experience for the students, and I look forward to refining that experience as I go forward in future years.