Repurposing the MCOP^2 Observation Protocol to Survey Students' Views of an Active Learning Course Redesign

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The goal of the Active Learning in Mathematics Research Action Cluster (RAC) is to study the process by which lower division university mathematics courses can be redesigned to engage students in active learning practices such as forming hypotheses, creating mathematical models and discussing their ideas with others. As with many other Mathematics Teacher Education Partnership (MTE-P) initiatives, implementing this vision involves successive Plan-Do-Study-Act (PDSA) cycles (Bryk, Gomez, Grunow, & LeMahieu, 2015). This paper reports on one such cycle that focused on developing a survey instrument to measure students' perceptions of active learning opportunities by transforming the Mathematics Class Observation Practices Protocol (MCOP^2; Gleason, Livers, & Zelkowski, 2015) from a teacher observation tool to a student survey.

The problem we were addressing was that while we had a *Plan* and were ready to *Do* the work, we didn't have a way to *Study* our implementation. Our *Plan* was to develop weekly modeling projects that would highlight real-world applications of the seemingly abstract functions studied in Pre-Calculus. In order to *Do* this, we had to work with our administration to augment the large lecture sections with small break out sections capped at 30 students, and to devise weekly labs that would include opportunities for active learning. Our *Study* of this work involved repurposing the MCOP^2 observation protocol (Gleason, & Cofer, 2013) into a student survey so we could get a picture of what the students thought about the labs and measure the degree to which these labs actually engaged students in active learning practices. The conclusion to this paper describes how we plan to *Act* to refine our redesign efforts in future semesters.

Background

One of the more far-reaching and comprehensive studies documenting the effectiveness of active learning in university science, technology, engineering and mathematics (STEM) courses was conducted by Freeman et al. (2014). In their meta-study of 225 research papers describing active learning in various settings, the authors conclude that student performance

Lawler, B. R., Ronau, R. N., & Mohr-Schroeder, M. J. (Eds.). (2016). *Proceedings of the fifth annual Mathematics Teacher Education Partnership conference*. Washington, DC: Association of Public Land-grant Universities.

on final exams and other conceptual tests increased by almost .5 standard deviations in classes with active learning versus traditional lecturing. In addition, other studies have found that active learning have demonstrated decreased failure rates (Henry, 2010), improved student engagement (Freeman et al., 2014), persistence in taking subsequent courses in the Precalculus to Calculus II sequence (Laursen, 2013) and improved attitudes toward mathematics for female and under-represented populations (Laursen et al., 2014). While all of these studies used different measures of success (final exam grades, persistence, and student attitudes, respectively), none of the studies actually measured the degree to which the students perceived they were engaging in active learning. Our goal was to develop a measure of the students' perception of active learning and try to identify the "value added" between the lecture and active learning labs from the students' point of view.

Description

The MCOP^2 tool was developed to help researchers measure the degree to which classroom practices align with various teaching reform documents such as the Standards for Mathematical Practice (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). We chose this tool because it focuses on many aspects of active learning and because it has been proven to be both reliable and valid (Gleason, Livers & Zelkowski, 2017). However, its use also poses some challenges. First, it is resource-intensive due to the need to train and pay observers; in our case the observers would have to observe at least five lectures and 32 break out sections multiple times across a semester. Second, it only captures snapshots of the lessons observed, and is limited to the observer's perspective. In order to capture the students' perspectives over the course of the semester, we modified the tool to be used as a student survey. Although one could argue that trained observers might be more astute at seeing opportunities for participation than students, our hypothesis was that if students do not see an opportunity for engagement (even if one may exist in the eyes of the observer), then they are not developing the metacognitive awareness needed to engage in these practices as they prepare for more challenging courses.

Our method involved three stages: (1) modifying the protocol and administering it online to all students enrolled in the course, (2) analyzing the modified protocol by conducting a confirmatory factor analysis, and (3) analyzing students' survey responses, including to the open-ended responses to questions regarding their enjoyment of various labs. During the modification process, we attempted to limit the amount of time students needed to spend answering items by rewording the items to accommodate both the lecture and lab settings. We cut the 16 MCOP^2 items in half, to ask the eight questions most relevant to student experiences, but then asked each question twice: once about students' experiences in lectures, and once for their experiences in the labs. Thus, for example, question 1 was stated as follows, "During my lecture class, students engaged in exploration/investigation/problem solving about how much of the time? [regularly, sometimes, seldom, never]". Question 2 read, "During my lab class, students engaged in exploration/investigation/problem solving about how much of the time? [regularly, sometimes, seldom, never]". Thus, all odd-numbered questions refer to lecture while even-numbered questions refer to labs. The eight pairs of items asked students about engagement in exploration/investigation/problem solving, use of tools, time to work on questions, discussion of solution strategies, perseverance, conceptual links within the mathematics, mathematical modeling, and precise mathematical language.

During the second phase of this work, we asked all students to take the survey online. Of the 706 students enrolled in 6 sections of the course, we received 504 completed surveys—over a 70% response rate. This return rate is significant enough to claim that the results are representative of most students. We examined the students' answers to the open-ended questions by determining the most common comments and putting them together in categories.

The analysis of the student responses involved conducting a confirmatory factor analysis to gauge the degree to which our students' answers aligned with the $MCOP^2$ factors that Gleason, Livers and Zelkowski (2015) found when they used an exploratory factor analysis to establish the reliability of the $MCOP^2$. Their initial factor analysis revealed two subscales: Teacher Facilitation and the Student Engagement. The teacher facilitation subscale (Cronbach alpha of 0.850) measures the degree to which the teacher plans lessons, promotes problem solving, and facilitates classroom discourse. The student engagement subscale (Cronbach alpha of 0.897) measures the degree to which students engage in the learning process.

Results

The results of the confirmatory factor analysis revealed that the $MCOP^2$ student survey did have the same factor structure as the original observation tool (Teacher Facilitation and Student Engagement). The five items chosen from the Teacher Facilitation scale and three items from the Student Engagement scale loaded onto separate scales for the $MCOP^2$ survey. However, within the two expected factors, two additional factors also emerged: LAB and LECTURE. Thus, the 16 total items could be split into four factors: Teacher Facilitation-Lab (5), Teacher-Facilitation-Lecture (5), Student Engagement-Lab (3), Student Engagement-Lecture (3). All four factors had good model fit according to model fit indices (Chi-square, CFI, TLI, RMSEA, and SRMR). In addition, all factor loadings and R^2 coefficients were statistically significant.

The modal responses for the lecture and lab are shown in Figure 1. As can be seen, the students rated the labs higher in every category than lecture in terms of offering opportunities for active learning. The two areas that showed the greatest "value added" were exploring solution pathways (Cohen's *d* effect size of .51) and discussion of solution strategies (Cohen's *d* effect size of .43).

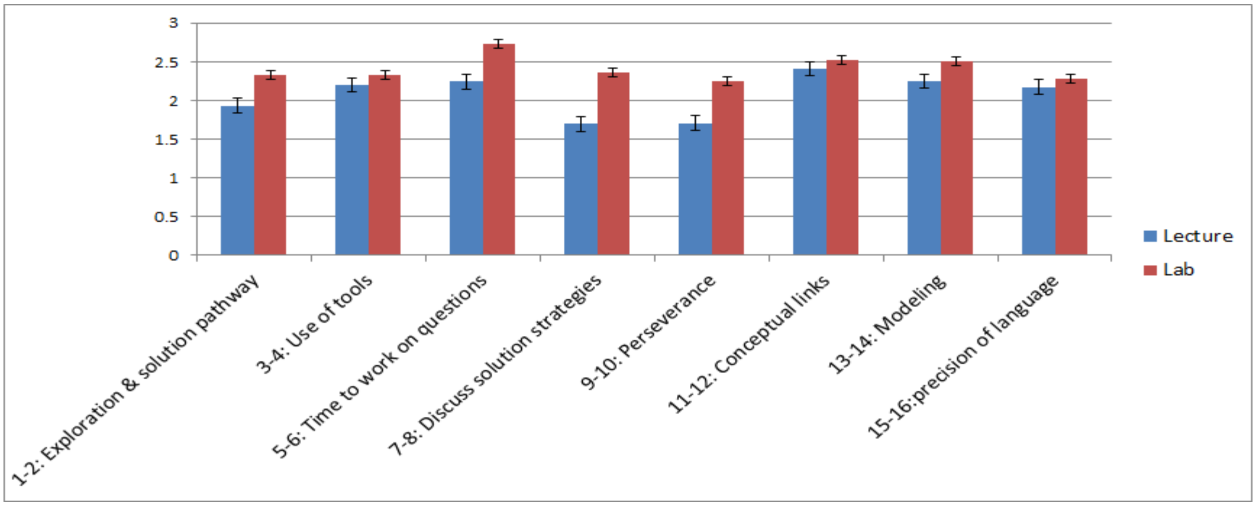

Figure 1. Modal responses on modified $MCOP^2$ from student reports of active learning in lecture and lab classes.

The open-ended results indicated that over 70% of students were either happy or very happy with the labs. In particular, many of them noted their relevance to real life. For example, one wrote "I enjoy the active labs where you have to get up and collect data by interacting with others. It actually makes math semi fun."

Conclusion

This study revealed two key findings that will inform our work going forward. First, the $MCOP^2$ student survey does align with the factors used to validate the $MCOP^2$ protocol, and hence appears to be reliable; since the larger RAC had already determined the $MCOP^2$ observation instrument to be a valid measure aligned project goals, a subset of these items posed as a survey would retain that validity. Second, the survey is useful for identifying what students believe are specific value-added aspects of active learning that the labs offer to augment lecture.

This work impacts our institution because we are in the process of redesigning the entire Precalculus to Calculus 2 sequence. Hence, we will be able to use the revised survey in all three courses to measure gains in active learning. The work contributes to MTE-P because it offers a second use for the $MCOP^2$ tool for members wishing to report students' perspectives and perhaps compare results with those of trained observers.

Our next steps for concluding this PDSA cycle are to *ACT* as follows: (1) revise the wording of the survey to make it more "student friendly," (2) compare student results with outside observers, (3) shift some of the choices from estimations of percent of student engagement to measures of personal engagement, and (4) compare survey students in lecture-only classes versus those who have both lecture and lab classes. Furthermore, other universities participating in the Active Learning Mathematics Research Action Cluster may begin to use the MCOP^2 survey to better understand their students' experiences in reformed mathematics classrooms.

For More Information

- For more information and/or to obtain a copy of the survey, please contact Janet Bowers at San Diego State University – JBowers@mail.sdsu.edu
- For more information about the confirmatory analysis methodology, please contact Wendy Smith at University of Nebraska-Lincoln – wsmith5@unl.edu
- The original MCOP^2 survey and documentation can be found online: jgleason.people.ua.edu/mcop2.html

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