Prospective Teachers Running Active Learning Breakout Sections: What We've Learned in Four Semesters

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Abstract

This chapter reports on a program in which undergraduate STEM majors teach active learning breakout sections for a precalculus course. Our goal is to determine what benefits the students experienced from teaching and whether these experiences influenced their decision to become teachers. The findings suggest that (1) several STEM majors who were not initially planning to teach stated that they are now considering teaching as a career, and (2) program participants who were prospective teachers developed their identities as mathematics teachers more strongly than their peers who did not teach breakout sections (even though both groups took the same prep courses). This report intersects the foci of three RACs within MTE-Partnership: Developing Effective Clinical Experiences; MODULE(S^2) Math of Doing, Understanding, Learning, and Educating for Secondary Schools; and Active Learning Mathematics.

Keywords: teacher recruitment, teacher training, active learning

Introduction

The major goal of the MTE-Partnership is to address the shortage of new secondary mathematics teachers who are "well prepared to help their students attain the goals of the Common Core State Standards for Mathematics (CCSS-M) (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010) and other rigorous state mathematics standards" (Martin & Gobstein, 2016, p. 2). This paper explores one internship program for STEM undergraduates that touches on three critical aspects of this issue: providing a teaching experience that might enable us to recruit STEM majors to consider teaching, providing authentic teaching experiences that can support productive habits of mind for teaching, and training STEM majors to teach using active learning in classrooms.

Background of the Program

The use of instructional student assistants (ISAs; a pay classification for undergraduates used on the San Diego State University campus) to teach breakout sections for precalculus was new to our department. Prior to our use, ISAs were hired to grade papers, run small sections of supplemental instruction, and help in other instructionally related tasks. However, they had never been allowed to actually teach as part of a credit-bearing course. Therefore, we were cautious as we planned the format of the class, the ISAs' role definition, their preparation and responsibilities, and the active learning activities that the ISAs were asked to implement in their sections.

Format. Prior to this program, precalculus was taught in lectures containing 150 students that met for 50 minutes three times per week. This was less than optimal for incoming freshmen who are generally in need of more attention, of the type a smaller, more intimate setting where people would notice absences and encourage more talk among students could provide. Therefore, we chose to eliminate one of the lecture sessions and form five breakout groups limited to 30 students each (see Figure 1). The goal of these sessions has been shifting. At the outset, we tried to structure lessons that included applications of the precalculus material to real-life applications. After four PDSA cycles, the emphasis has shifted more toward creating experientially real activities in which students can engage in mathematical argumentation and exploration with an implicit goal of developing more robust mathematical mindsets.

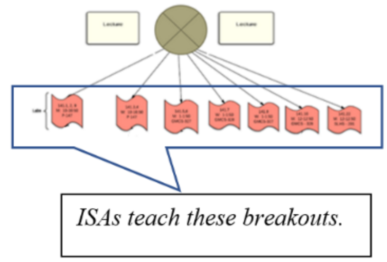

Figure 1. ISA breakout groups.

Role definitions. As undergraduates, the ISAs are not instructors of record. As "near peers," we see their role as a broker between the collegiate world and the rather difficult life of first-time freshmen. In particular, we hoped ISAs would serve as STEM role models (Nickerson et al., 2017). Each ISA ran two breakout sessions, attended lecture, graded approximately 60 students' homework and tests (although not their own students), and reported attendance to the instructor of record.

Preparation and training. The ISAs are required to attend three full days of pedagogical training during the semester prior to their teaching. About half of this time is spent learning about teaching ideas alongside the GTAs. The remaining time was spent with the director discussing the specific pedagogical goals and mathematical content knowledge needed to implement the activities. For example, during one of these training sessions, each of the ISAs got up before a small group and role-played how they would introduce a topic. Then the other ISAs would pretend to be students offering correct and incorrect answers. The group discussed pedagogical techniques such as avoiding the Elicitation-Response-Evaluation pattern when leading discussions. The student leader cohorts also met weekly with the program director to discuss the following week's lesson plan, the prior week's successes and opportunities for growth, the calculational and conceptual ideas underlying the mathematics to be covered, and ways to improve the program in general. The overall question we seek to answer is: what effects did this experience have on the participants' identities and mathematics teachers and their views of active learning?

Conceptual Framework: Developing Identities for Mathematics and Teaching

We are currently developing a framework to conceptualize how to measure the effectiveness of the ISA program. Our view is that these ISAs develop identities for themselves both as teachers (while teaching and planning) and as mathematicians (while they are studying). Therefore, we attempt to integrate research regarding the development of one's mathematical identity and one's teaching identity.

One of the most prominent efforts to support the development of students' mathematical identities is run by Jo Boaler, who bases some of her work on the mindset theory developed by Carol Dweck (2006). In her work, Boaler (2015) claims that mathematical skills – and by extension mathematical identities – are not fixed; the experiences we have in life are much more influential to our growth than the size or potential we have when we are born. Math geniuses are not "born," they develop through passion and hard work. To encourage a mathematical mindset within their students, teachers need to first believe in the tenets of widespread potential, and then act on this belief by emphasizing open-ended classroom activities with active learning, praising students for their perseverance and grit rather than using words such as "genius," and celebrating the value and importance of making – and learning from – mistakes.

Research on teacher professional development focuses on the idea that the ongoing construction of one's identity as a teacher is a critical component of personal growth. While prospective teachers look forward to making the physical shift from being students of education to teachers in their own classrooms, their mental transition often takes much more time and evolves as they engage in increasingly authentic practices in the field (Pittard, 2003). One of the most often-cited impediments to this transition is the mismatch between pre-service teachers' experiences with coursework and their practicum experiences. This mismatch can be addressed by providing experiences all along what Grossman (2010) calls the "authenticity scale." For prospective teachers (or STEM students who may consider teaching), engaging in these authentic experiences with appropriate supports and feedback enables them to build both skill and confidence.

This framework guides our basic question: Do STEM majors who participate in the ISA program report differences in their development of a *mathematics teacher identity* when compared with prospective teachers who did not participate?

Alignment to MTE-Partnership Networked Improvement Community methodology (PDSA cycles)

Our work aligns with the MTE-Partnership goal of addressing the teacher shortage by engaging both majors and non-teaching majors in the authentic activity of teaching in a college-level active learning setting. We have run four iterations of the PDSA cycle, reflecting and changing as we went along. The main changes fall within two categories: nature of the lab activities and training of the ISAs. When we first began, our goal was to bring more application tasks into the teaching of precalculus concepts. Thus, we created a lab focused on developing a quadratic model of a ball rolling down a plank and a study of pH to exemplify a use of logarithms. After talking with the students and ISAs, we slowly began to focus more specifically on the social component of engagement rather than the real-life applications. One of our greatest successes was a lab that involved the simulated spread of a virus using successive coin tosses among the students. This was fun because the data was real and compiled by the group as a whole, and never looked the same between lab sections. However, as a visitor pointed out, the students were actively engaging in the *collection* of the data, but not in the creation of the model. This was a terrific insight and one that has focused us on training the ISAs to make sure that students are the ones doing the mathematical heavy lifting. Of course, the ISAs rightly realized that if students had been hand-fed the models in all of the other labs, then they would wait for this one as well. Hence, our next iteration is going to focus more solidly on engaging students in *experientially* real tasks (which may or may not be real-life applications) with the goal of building math mindsets in the spirit of Boaler (2015).

Methods

Gathering information from ISAs who have graduated is very difficult, particularly as graduates do not always update their contact information with their alma mater. Given the difficulties, we determined a survey would be the best way to collect uniform data as a baseline. The desired pool of survey candidates included: all single-subject majors (undergraduates enrolled in the program designated for high school math teaching), including both those who served as ISAs (response rate 7 out of 12) as well as those who did not (response rate of 6 out of 22), and all applied math majors who served as ISAs (response rate of 4 out of 8).[1] Two email invitations were sent out in early May: one by the first author (a known name who coordinates the program) and one by the

[1] Most all ISAs worked more than one semester, hence the totals shown in Figure 1 are higher than the total pool referenced in the response rate.

second author (a peer and fellow ISA). All responses were blind, so we do not know the gender or ethnicity of the respondent pool.

Data coding proceeded by coding the Likert Scale responses using an interval scale of 4 (strongly agree) to 1 (strongly disagree).[2] Although still somewhat controversial, we believe that this coding makes sense because a shift from a 1 "strongly disagree" to a 2 "disagree" is roughly equivalent to a shift from a 3 "agree" to a 4 "strongly agree." Therefore, while we did compute some averages, most analyses involved simple frequency counts. In addition, due to very small number of responses, percentages were not calculated.

Results

Our first question was to determine whether this program affected the ISA participants' future plans to attend a teacher credential program. As shown in Figure 2, there were two ISAs who were applied math majors who now considered applying to a credential program, and a third who definitely decided to choose teaching as a career. It is also the case that one ISA, who was initially a single-subject major, then decided not to pursue a credential in teaching. This is also a positive outcome as some students need to find out before they enter a credential program that teaching is not for them. Comparing these results to the pool of single-subject students who were not ISAs, a larger percentage of those single-subject majors who were *not* ISAs were undecided about whether to go into a teacher credential program. The numbers are too small to make statistical claims; we present these outcomes as some of the possibilities when students are engaged as ISAs.

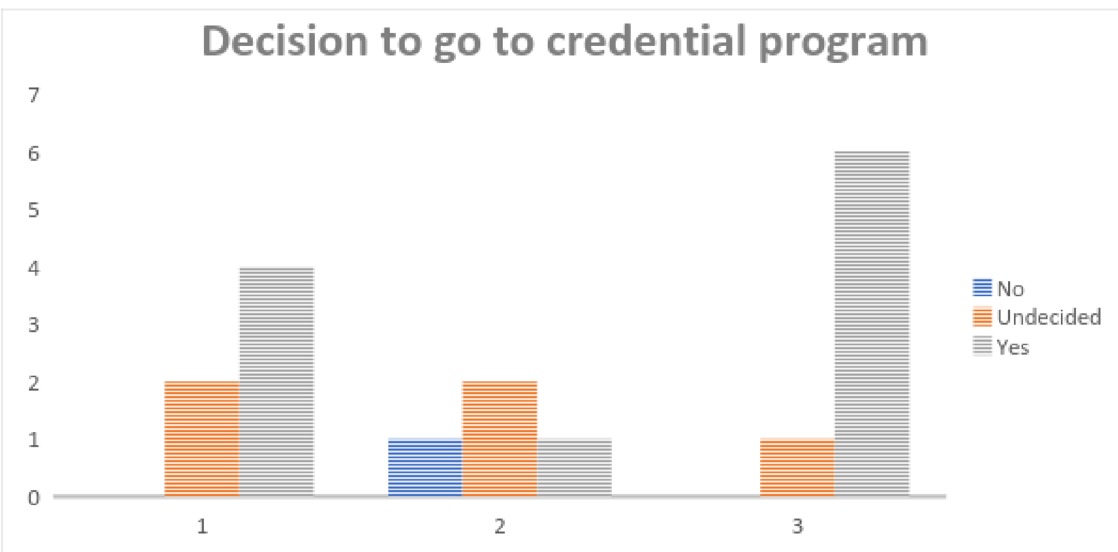

Figure 2. The decision to pursue teaching for ISA versus non-ISA students divided by major.

A second goal of the survey was to identify which of the various teaching opportunities within and beyond the ISA program and single-subject curriculum were most influential in students' development of teaching and mathematical identities. The experiences we considered, ordered from most to least authentic (Grossman, 2010),

[2] This practice is controversial in some fields, but quite common in educational research. See *Is a Likert-type scale ordinal or interval data?*. Retrieved from: https://www.researchgate.net/post/Is_a_Likert-type_scale_ordinal_or_interval_data

were (1) serving as an ISA, (2) tutoring in some other capacity, (3) watching a class through a state of California required Early Field Experience, (4) completing the capstone course (Math 414- required for all prospective teachers), and (5) doing some other work (e.g., working in a school as an aide or tutor, or, more likely, any paid position such as barista or makeup artist).

Table 1 uses conditional formatting (red as lowest, green as highest) to highlight the experiences that respondents rated as influencing their thoughts about teaching. As can be seen, *work* (not tutoring) was the experience most often cited by the non-ISA group as influencing their thinking about teaching. In contrast, all of the students in the ISA group cited being an ISA as an influence in their views about teaching. A majority of the ISAs also cited their teaching as being a source for experiencing the satisfaction of helping a student understand a topic and many said that they felt that they had influenced learners. Researchers have cited intrinsic motivators such as these to be particularly important considerations for those choosing a career in teaching (cf., Richardson et al., 2013). Thus, more ISAs (who were single-subject majors) identified the ISA experience as providing opportunities for learning about teaching than any of the other aspects of the single-subject program, including working as a tutor, observing classrooms in an early field experience and taking the capstone course.

Table 1

The various influences and sources for experiences within the single-subject math program

	Non ISA						ISA					
	ISA	Tutor	EFE	414	Work	n/a	ISA	Tutor	EFE	414	Work	n/a
I felt inspired to continue pursuing teaching as a career.	0	1	1	2	4	0	5	2	3	8	9	2
I have learned new pedagogical skills.	0	1	1	2	1	2	11	6	2	3	1	1
I made an impact on the student(s) I interacted with.	0	2	2	0	3	1	9	8	3	0	3	1
I thought about mathematics conceptually.	0	0	0	1	3	2	10	6	3	4	1	1
I have increased my confidence in my ability to teach mathem...	0	1	2	1	4	1	11	9	3	2	2	1
I saw students performing algorithms but not understanding the logic behind them.	0	1	1	0	1	3	9	6	4	0	1	1
I considered becoming a teacher.	0	1	1	1	4	1	10	7	3	3	3	1
I questioned whether I wanted to be a teacher or not.	0	0	0	1	3	2	5	1	1	1	2	6
I realized how much more work teaching is that it appears.	0	0	2	0	1	2	10	1	4	3	3	1
I've experienced the satisfaction of a student saying they now understand a topic.	0	2	2	0	2	2	12	8	2	0	2	0
I've decided that I do not want to be a teacher.	0	0	0	0	0	5	1	0	0	0	1	10

Our third area of interest in this preliminary work was to explore any differences between the math teaching identities of the ISA and non-ISA groups. Using questions that reflect the major ideas of Boaler's work, we asked several questions about various teaching practices.

Strand 1: Clear Lecturing. One strand of questions focused on whether a teacher should present lectures in clear, step by step ways. Given that these prospective teachers learned effectively from lectures as math students, both the ISA and non-ISA groups strongly agreed with all items relating to presenting a clear lecture. This is not what we had hoped, but it may have been that students were contrasting *clear lecturing* with *unclear* *lecturing* rather than with more active learning strategies, and thus agreeing with clarity in mathematical expectations.

Strand 2: Expectations for Students. We asked several questions relating to the prospective teachers' expectations for how students should engage with mathematics in breakout sessions. These were based largely on the Common Core Standards for Mathematical Practice. Other items focused on equitable teaching practices, such as: I will only call on students who raise their hands. I don't think it's fair to expect everyone to be ready to participate.

Strand 3: Growth Mindset for Teaching. We applied Dweck's view (i.e., geniuses are not born, but emerge through practice) to the development of "good teachers." Here, we saw an encouraging difference: the prospective teachers who had been ISAs disagreed with this statement more than prospective teachers who did not have the ISA experience. As shown in Figure 3C, this strand showed the largest differences. The interquartile range for the ISA was much smaller than for the non-ISA group. This indicates that there was a similar feeling among ISAs that teachers can become better.

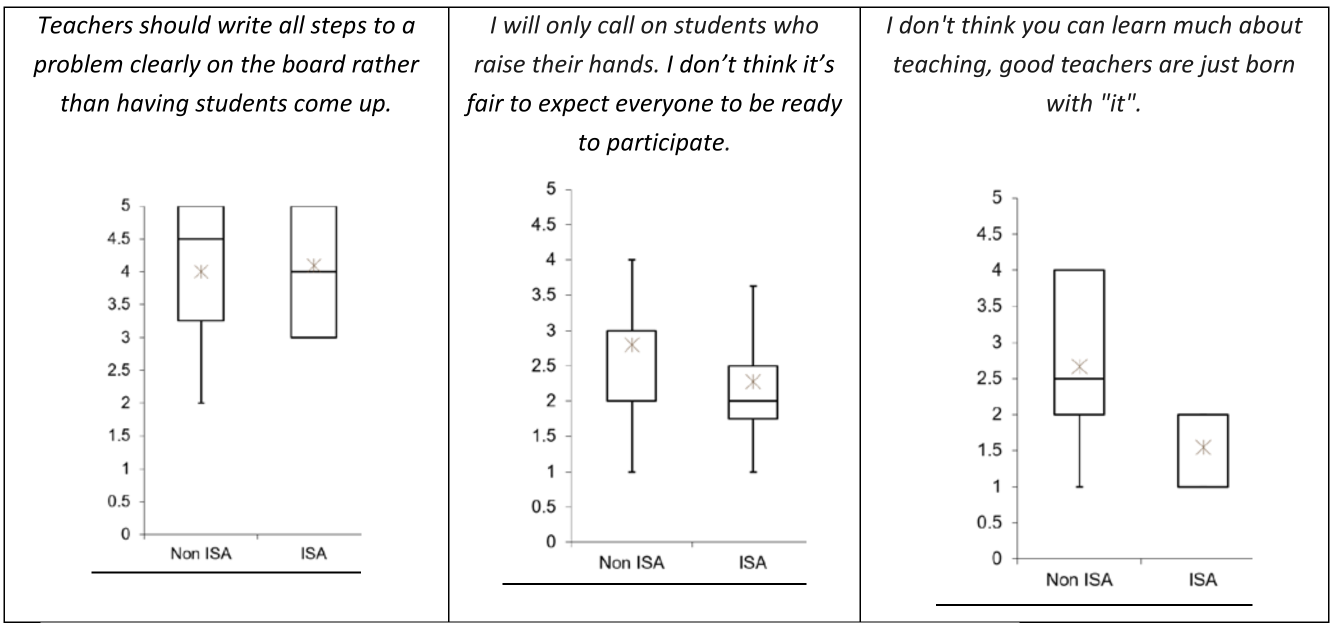

Figure 3. Box-and-whisker plots showing results from ISA and non-ISA survey respondents.

Conclusion

We have learned a great deal from this work and are encouraged to keep the ISA program going. We have found that it provides authentic opportunities for ISAs to learn new pedagogical skills, feel the intrinsic satisfaction of helping peers, increase their confidence in mathematics, and gain insights into the amount of work involved in teaching. These benefits convinced at least one applied math major to choose a career in teaching, and for two others to consider applying for a credential program. These findings impact the field of teaching in that we are providing some more experienced and curious math teachers for the local partnership. It is also a win for our institution because our students receive help and support from near peers—who serve as influential role models (see Nickerson et al., 2017). The department benefits since hiring ISAs costs less than half the cost to hire graduate teaching assistants (which are in short supply). Our next steps involve focusing on working with client disciplines to develop more appealing labs, and to increase the amount of training for the ISAs in the form of pre-semester help (featuring presentations from alumni ISAs) and in-semester feedback to support their development of fluency with discrete teacher moves such as asking higher-order questions.

For More Information

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