Inculcation of Pre-service Mathematics Teacher Social Consciousness Through Social Justice Mathematical Modeling Projects

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Abstract

The challenge for teacher educators of ensuring pre-service mathematics teachers develop sensitivity to the social-contextual factors that affect the teaching and learning of mathematics looms large. One way this can be addressed is through the incorporation of mathematics for social justice projects into existing curriculum. In this presentation, we discuss the results of the test enactment of a mathematics for social justice modeling project with pre-service teachers of mathematics and statistics. Participants engaged in the mathematical modeling process by making assumptions, identifying variables, and creating, refining, and implementing a mathematical model intended to identify inequities created and perpetuated by “tracking” in school mathematics. Participants documented the development and results of their model in a technical report wherein they provide education policy recommendations intended to dismantle inequitable structures they identify in the system of mathematics education. We present evidence from student work samples for a productive evolution of social consciousness among participants.

Introduction

During recent years, the mathematics education community has seen an outpouring of articles, books, and position papers by mathematics teachers, mathematics education researchers, and professional teacher and teacher educator organizations discussing the imperative for attending to issues of equity in school mathematics (see, for example, National Council of Teachers of Mathematics, 2014, 2018; National Council of Supervisors of Mathematics & TODOS, 2015; Association of Mathematics Teacher Educators, 2017). This call for equity is also embedded throughout the Mathematics Teacher Education Partnership’s (MTE-Partnership) Guiding Principles for Secondary Mathematics Teacher Preparation, and indicators 5-E and 6-C have special relevance to this report. Guiding Principle 5 refers to candidates’ knowledge and use of educational practices, and indicator 5-E states that pre-service teachers need to finish their teacher preparation program with the recognition that “all students in their classes—including low-performing students; gifted students; students of different racial, ethnic, sociolinguistic, and socioeconomic backgrounds; English language learners; students with different sexual orientations; and students with disabilities—have the potential to make important contributions,” (p. 5) and that teacher candidates must maintain high expectations for all students. Guiding Principle 6 refers to professionalism, advocacy, and leadership, and indicator 6-C states that candidates require preparation as agents of change “so that through their actions, behaviors, and advocacy, [they] demonstrate a dedication to equitable pedagogy that promotes democratic principles by holding high expectations for all students, while recognizing and honoring their diversity” (Mathematics Teacher Educator Partnership, 2016, p. 5). In this paper, we report preliminary results suggesting the cultivation of social consciousness, that is, an awareness of and sensitivity to the social and cultural contexts in which students learn and do mathematics and the belief in their importance for equitable mathematics.
teaching practice, in 12 pre-service teachers of mathematics by way of a social justice-oriented mathematical modeling project.

**Problem and Purpose of Study**

There is little, if any, disagreement among stakeholders in school mathematics with the idea that all students deserve access to mathematics with a high level of cognitive demand from a capable teacher, at least in principle. Unfortunately, this consensus has done little to diminish many mathematics teachers’ views of the practice of tracking. According to several sources, tracking, the “practice of dividing students into separate classes for high-, average-, and low-achievers,” (a practice the Association of Mathematics Teacher Educators (AMTE) refers to as “oppressive”) seems to count teachers among its most ardent supporters (AMTE, 2017; Brentnall, 2016; Burris & Garrity, 2008; Keller, 2011; Oakes, 2005). The 2018 National Survey of Science and Mathematics Education appears to support this conclusion. Of middle school and high school mathematics teachers polled, 66% and 70% respectively, agreed with the statement “Students learn mathematics best in classes with students of similar abilities,” and only 36% and 33% consider themselves well-prepared to “Differentiate mathematics instruction to meet the needs of diverse learners.” Finally, the results from the 2008 *MetLife Survey of the American Teacher* indicate that 43% of respondents agreed with the statement, “My class/classes in my school have become so mixed in terms of students’ learning ability that I/teachers can’t teach them” (Markow & Cooper, 2008).

Dispositions toward tracking are not the only concerning result from the survey. Only 49% of middle school and 46% of high school math teachers consider themselves prepared to “encourage participation of all students in mathematics,” 37% of middle school and 38% of high school math teachers feel able to “encourage students’ interest in mathematics,” 23% of middle school and 26% of high school math teachers feel adequately prepared to “provide mathematics instruction that is based on students’ ideas,” and 13% of middle school and 17% of high school math teachers believe they can “incorporate students’ cultural backgrounds into mathematics instruction” (Banilower et al., 2018). Put differently, teachers do not feel prepared to utilize equity-based teaching practices (Aguirre, Mayfield-Ingram, & Martin, 2008).

How can we ensure that students leave our teacher preparation programs understanding that “the social, historical, and institutional contexts of mathematics affect teaching and learning and know about and are committed to their critical roles as advocates for each and every student” (AMTE, 2017, p. 21)? The answer is certainly multifaceted, but one point of interest with the potential to address a host of other issues is that of teacher beliefs. A large body of research suggests that teacher beliefs about effective pedagogical practices, about which students should or are capable of learning cognitively demanding mathematics, and about what it means to do mathematics, have a profound impact on their teaching practice and on the achievement levels of their students (van den Bergh, Denessen, Hornstra, Voeten, & Holland, 2010; McKown & Weinstein, 2008; Rubie-Davies, Hattie, & Hamilton, 2006; Staub & Stern, 2002; Rosenthal & Jacobson, 1968). Far less understood than the impact of teacher beliefs are the mechanisms underlying their formation and eventual acceptance (Bell, Halligan, & Ellis, 2006).

**The State of Research into Teacher Belief Inculcation**

Studies where researchers attempted to alter teacher beliefs are far fewer than those attempting to understand their impact, but what research has been performed provides us with a starting place for identifying effective means to the inculcation of social consciousness. For example, explicitly challenging the beliefs of pre-service teachers and requiring reflection seems to be an integral component of effective attempts to inculcate new beliefs and alter teaching practice (Caudle & Moran, 2012; Conner, Edenfield, Gleason, & Ersoz, 2011; Turner, Warzon, & Christensen, 2011). Furthermore, teacher candidates who receive instruction in the way they are
expected to teach, who are witness to the successful implementation of innovative teaching practices, are more likely to use innovative teaching practices and possess stronger belief in their own capacity to teach (Jao, 2017; Katz & Stupel, 2016; Lloyd, 2013; Lloyd, 2018; Loucks-Horsley, 2010). While successful, these attempts have been relatively disparate, making comparison a challenge and severely complicating, but also highlighting the need to address the problem of developing a general theory of teacher belief inculcation. Only further complicating the situation is that there appears to be no common definition of “belief” underlying and unifying existing studies of teacher belief. Recent efforts in the realm of cognitive psychology provide a promising roadmap to a framework of belief that might be co-opted by teacher educators.

**The Potential in Social Justice Mathematical Modeling**

It is our belief that not only should teacher educators not shy away from discussing sensitive topics (e.g., issues regarding race and/or politics) in the classroom, but that they should be encouraged to do so, and that such “hard topics” can serve as the basis for mathematically rich, cognitively demanding tasks that can, and should, be incorporated into public school mathematics classrooms. This form of mathematics pedagogy, known as mathematics for social justice or teaching mathematics for social justice, seeks to situate students of mathematics as agents of change by engaging them in cognitively demanding mathematical tasks that require them to analyze issues of fairness in society (Gutstein, 2005). While related, mathematics for social justice should not be confused with the ongoing struggle for social justice in mathematics education. The distinction between the two may be illuminated by a (particularly relevant) example: eliminating tracking in school mathematics is an issue of social justice in mathematics education while providing students with the opportunity to critically analyze the inequities created and perpetuated by tracking using mathematics is an example of mathematics for social justice.

In addition to providing pre-service teachers with an opportunity to engage in a mathematical task possessing a high level of cognitive demand, the use of a mathematical modeling project provides additional benefits by incorporating several of the components that contribute to a change in teacher beliefs, including the successful utilization of innovative teaching practices and ongoing reflection. To this end, this study attempted to change pre-service teachers’ beliefs and inculcate social consciousness by engaging students in a social justice mathematical modeling project during eight weeks of a methods course.

**Project Design Framework**

In this study, pre-service teachers were tasked with answering the question “How does ‘tracking’ in school mathematics affect students’ achievement?” through the lens of equity, by way of developing a mathematical model. Note that we employ the term *mathematical modeling* in the manner of the Consortium for Mathematics and Its Applications (COMAP) and the Society for Industrial and Applied Mathematics (SIAM) as described in their joint effort publication *Guidelines for Assessment & Instruction in Mathematical Modeling Education* (GAIMME) (COMAP & SIAM, 2016). The project was structured after the HQPBL framework, which requires adherence to six criteria: intellectual challenge and accomplishment, authenticity, a public product, collaboration, project management, and reflection (Buck, 2018). Students were randomly placed in groups using the automatic group creation utility on the Canvas Learning Management System and were required to meet several times throughout the semester.

The project was enacted in a course titled Methods of Secondary School Mathematics Teaching, for pre-service mathematics teachers, and facilitated by an outside student researcher. Participants had received general instruction regarding the mathematical modeling cycle, as envisioned in the GAIMME report, shortly before being introduced to the project. The facilitator introduced the project by providing the pre-service teachers with a framing narrative, where participants were imagined as education policy researchers for a fictitious think-tank called the “MacGuffin Institute,” by way of an initial slideshow presentation and discussion on the difference
between equality and equity. Following a general discussion of equity, the concept of tracking in school mathematics was introduced and participants were encouraged to share relevant experiences. Participants then took a few minutes to answer some prompts regarding what information they deemed important for the central project question. Then teams were set to work on the initial task sheet after which they were directed to begin the work of producing a mathematical model intended to explore differences in student outcomes. One week later, participants were contacted electronically with the next set of instructions, wherein they were directed to develop an initial mathematical model and reflect on their progress. Three weeks later, they received in-class time to work on their models and to ask questions of the project facilitator. In addition, they were provided with another task sheet that included directions to: read excerpts from the National Council of Teachers of Mathematics (NCTM) publications *Principles to Actions: Ensuring Mathematical Success for All* (2014) and *Catalyzing Change in High School Mathematics: Initiating Critical Conversations* (2018) that discuss tracking; revise their mathematical models based on what they learned from the reading assignments; complete and submit their team’s technical report; and write and submit a final reflection following the submission of their team’s report. In their technical report, teams were directed to explain the process of developing, testing, and revising their model, and to provide policy recommendations for education policymakers intended to address the inequities they identify. Participants were encouraged to seek assistance outside of the classroom from the project facilitator. Following a brief look at the different approaches each team took in the development of their model, and the different results they produced, the teams participated in a final discussion of tracking that highlighted the ways in which it acts as a barrier to learning mathematics and disproportionately negatively impacts certain demographics of students. This discussion was planned to follow the structure outlined by Smith and Stein’s *5 Practices for Orchestrating Productive Mathematics Discussions* (2018). Following the discussion, the participating pre-service teachers were directed to write down two to three specific actions they intended to take to challenge inequitable structures in their future careers as secondary mathematics teachers.

**Conceptual Framework for Analyzing Belief Inculcation**

Belief is only beginning to receive the consideration it is due among cognitive neuropsychologists (Bell et al., 2006a). This being the case, it should come as no surprise that a cognitive account of mathematics teacher belief formation has yet to be suggested in the literature. However, attempts by researchers to influence teacher beliefs taken together with what information cognitive psychology offers about belief formation can provide us with a starting point to account for and, consequently, better inculcate productive beliefs in teachers.

For this research we adopt a specific definition of belief, namely “the mental acceptance or conviction in the truth or actuality of some idea” (Connors & Halligan, 2015, p. 1). In an attempt at systematizing our efforts of social consciousness inculcation, we chose to use the five stages of belief as proposed by Connors and Halligan as an underlying framework for understanding the cognitive processes in which individuals engage when encountering new beliefs (see Figure 1).

Belief formation, by their account, begins with a precursor, an internal or external trigger, which is immediately followed by a search for meaning. During this stage, the individual explains or accounts for the precursor and then situates it within their existing “web of beliefs” (Connors & Halligan, 2015, p. 7). This process results in one or more “proto-beliefs” (Connors & Halligan, 2015, p. 8) intended to account for the trigger. Next comes the candidate belief evaluation, wherein the individual evaluates the proto-beliefs in terms of their “observational adequacy” (i.e., how well it/they explain the trigger) and “consistency with pre-existing beliefs” (Connors & Halligan, 2015, p. 8). Should a proto-belief survive this investigation, the next stage, that of accepting and holding the belief, is initiated, though the conviction with which the belief is held may vary significantly depending on the details of the evaluation that resulted in its acceptance. The final stage describes the consequential effects of holding the belief. These effects can be far reaching, as the individual will “perceive the
world in a way that is consistent with the new and congruent existing beliefs” (Connors & Halligan, 2015, p. 10). In other words, just as the individual’s existing beliefs prior to the precursor to the newly accepted belief influenced its formation, so too will the formation of future beliefs be influenced by the newly accepted belief (Connors & Halligan, 2015).

The creators of the stages of belief framework, recognizing the limits of their account of belief, advise caution with respect to the operationalization of their model, though they do “suggest that a complete theory of belief will need to account for at least these five stages” (Connors & Halligan, 2015, p. 10). Following their recommendation, while we attempt to align student work with the framework to gain insight into the process of pre-service teachers’ belief development, we recognize the complexity of belief formation and the limits of the stages of belief framework and, therefore, do not employ the framework as a strict coding system.

![Figure 1](image.png)


### Methods and Procedures

Data collection made use of written assignments including: an initial task sheet; two reflection journals, one written near the beginning of the project and one following the submission of the pre-service teacher team’s technical report; and an action plan written immediately following the final in-class discussion of the modeling approaches taken by different teams and the social justice implications of tracking.

The initial task sheet included a prompt asking students to reflect on and list their own perspectives and biases regarding the issues of tracking. The first reflection journal included prompts addressing multiple facets of the project, but only one intended to elicit student responses for gaining insight into their beliefs.

1. *Do you agree with the organizations that claim tracking creates and reinforces social inequities and is actually oppressive? Why or why not?* (For example: [https://amte.net/sptm/chapter-6- elaborations-standards-preparation-middle-level-teachers-mathematics/standard-c4](https://amte.net/sptm/chapter-6- elaborations-standards-preparation-middle-level-teachers-mathematics/standard-c4))

The second reflection journal also included two such prompts.
1. Write down what you consider to be the most important thing you have learned about the practice of tracking in school mathematics.

2. Write down a specific plan you intend to enact to ensure that you are working to challenge inequitable structures like tracking in your future career.

The action plan involved a single prompt, issued verbally by the project facilitator, to write down, in two or three sentences, a plan for how they will promote equity in their future classroom and challenge inequitable structures within their own school.

Of the 12 pre-service teacher participants, eight submitted the initial task sheet, 10 submitted the first reflection journal, 11 submitted the second reflection journal, and 11 were present to complete the action plan writing assignment. In addition, it is unclear what number of students completed the reading assignment, and therefore the degree to which they incorporated the ideas found therein in a revised mathematical model.

Pre-service teacher writing assignments for each individual were read and situated within the five stages of belief formation to gain insights into the evolution of students’ beliefs and, therefore, of social consciousness. Evaluation of student work was performed by the researcher/project facilitator, and the course instructor and researcher reviewed and reflected on the in-class discussions associated with the project. As this is a preliminary study, no formal instrument was utilized for evaluating student work with respect to changes in belief.

Data Analysis

The initial task sheet prompt, wherein participants were asked to list their own perspectives on and biases regarding the issue of tracking, failed to consistently provide clear insights into students’ views of tracking. The reflection journal entries provided the clearest insights into the students’ changing (or nonchanging) beliefs over the course of the project. The action plan provided some evidence of an evolution of social consciousness in the participating pre-service teachers by way of the commitments they chose to make. However, none of the participants made specific mention of the issue of tracking itself, opting instead to focus on specific related issues like maintaining high expectations for all students, advocating on behalf of students, and challenging the practice of teacher tracking, i.e., the widespread practice of placing inexperienced teachers in charge of remedial mathematics courses.

All 12 participants appear to have experienced some degree, however small, of productive evolution of social consciousness; though, as is the case with any research relying on a form of self-reporting and given that participants were aware that their writings would be used for research purposes, we cannot discount the possibility that changes in participant rhetoric regarding the use of tracking in school mathematics may be due to the Hawthorne Effect, that is the tendency of the participants to behave differently than they normally would because they know they are taking part in a study (Corsini, 2001; McCambridge, Witton, & Elbourne, 2014). In addition, it must be pointed out that while we situate pre-service teachers’ written submissions within the five stages of beliefs formation described above, it is likely that participants experienced multiple iterations of stages of belief formation, with numerous beliefs, and at multiple times throughout the project. That is, even if the statements found in the student work examples below do in fact align with the stage of belief development we suggest, they may come from entirely different iterations of belief development, or from the development of different beliefs altogether.

Of the 12 participants, three appeared to have begun the project already believing that tracking creates and perpetuates inequities, and so no belief inculcation may have been necessary or possible. For example, one student wrote in their first journal entry that, “I don’t actually think that the benefits that it [tracking] provides are enough to make up for the bad effects on the other students.” Their existing web of beliefs may have either
already included the belief that tracking is harmful, or was well-equipped to quickly situate the precursor, quickly leading to the acceptance of the new belief.

In one of the starker examples, one participant admitted early on that their past experiences in school mathematics have contributed to their holding views that

Students in AP Classes/Honors are smarter, work harder, are better. Students in Remedial classes aren’t as smart, hard working [sic], or dedicated as those in AP classes. Students who get dropped down for AP or honors classes didn’t try hard enough. Students at the ‘normal’ level are equivalent to those in remedial classes.

The participant provides us with some valuable insights into their “web of beliefs” on the nature of how they understand success in school mathematics. Four weeks later, the same participant wrote,

When I was first introduced to this topic, I thought that tracking was a good thing, because it challenged students. As the class and I have engaged in discussion, I was able to get a different view from the experiences of my classmates. It made me think critically about the downsides of tracking. As to whether I agree or not with the claims that tracking reinforces social inequalities and is actually oppressive, the verdict is still out for me. I hope that it is a good thing but based on the data I’ve seen and the experiences my classmates have shared, I’m starting to believe that it may not be good [sic] thing.

The participant appears to be evaluating proto-beliefs as possible explanations for the concerning data they encountered and is at the same time reevaluating the original unproductive beliefs about tracking. An additional three weeks later, the student appears to have accepted one of the proto-beliefs, concluding,

I think the most important thing that I have learned about tracking is how harmful it can be. I’ve never considered it to be harmful, but I was always in the ‘advanced’ classes. This project helped me see the opposite side, when students are placed in ‘remedial’ classes, and the damage that it can do to the students. It helped me to see the side that I was unfamiliar with and has actually helped me see that tracking is harmful to many students. I thought it was a good thing when we started this project, but now I think that it is a harmful thing to most students, remedial and/or advanced.

One week later, in the action plan written immediately following our final classroom discussion of tracking, this pre-service teacher expressed the intention to “be an advocate for students who aren’t receiving the support they need.” Without a longitudinal study we will be unable to determine the conviction with which the newly accepted belief is held, and therefore whether it will actually shape the actions and future beliefs of the participant. However, this response may indicate what form consequential effects of holding the belief might take.

Another two participants, while possibly exhibiting a weakening of resolve in their conviction that tracking benefits students more than it harms them, never appear to have accepted a productive belief about tracking. In their first reflection journal entry, one of these students wrote,

I don’t agree with the organizations that claim tracking creates and reinforces social inequalities and oppresses students. I believe that tracking schools actually help students develop math skills at their own level. If they need remedial help for mathematics then they should take remedial math classes to help them catch up to the regular level students are at. Then when they no longer need remedial classes they should be able to take regular classes. When the students’ skills surpass their peers in regular classes then they should take advance [sic] honors math classes. Tracking schools [sic] goals are to improve each student’s mathematical skills and to teach each student at their own level.

This participant appears to have accommodated the information of the precursor, i.e., that tracking creates and perpetuates inequities, within their existing system of beliefs. We cannot be certain whether the participant evaluated other candidate beliefs or immediately situated the new information within their web of beliefs in an
initial search for meaning. Their second reflection journal entry appears to show no change in belief, with the student writing,

The most important thing I have learned about the practice of tracking in schools is that it is supposed to help students learn at their own level. Every student is at a different level of learning and some students need more help than others so tracking is a way of incorporating equity in schools. This purpose is to give students an opportunity to learn math concepts at their own level.

The participant may have evaluated other beliefs, but none appear to have been accepted. In the same entry the participant appeared to exhibit at least a willingness to remain open to alternative conclusions regarding tracking, expressing their commitment to “gather data from student performance based on this knowledge and after years of teaching and collaborating with teachers of different schools that are tracking or non-tracking, I will come to a conclusion about the effectiveness of tracking.” The student does appear to have undergone some evolution of social consciousness, however slight, with the student expressing their intent to employ “differentiated learning techniques” to accommodate students of varied achievement levels.

Of the remaining six participants, two began with a neutral view of tracking and later concluded the practice is harmful, three began with a neutral view of tracking and retained that perspective for the remainder of the project (though two of them committed to differentiating instruction for diverse learners while the other to continuing a critical analysis of tracking in their action plans), and one only submitted the action plan wherein they made a commitment to hold all students to high expectations.

Results

The Connors and Halligan (2015) stages of belief served as the underlying theory for understanding how the use of mathematical modeling projects may serve to help inculcate productive, equitable beliefs. Long-term mathematical modeling projects provide teachers with multiple opportunities to introduce precursors intended to challenge pre-service teachers existing beliefs. They also provide pre-service teachers with candidate beliefs in the form of model results and conclusions from their own work and that of their peers, with teacher feedback and questioning regarding their assumptions and choice of variables, and with time to evaluate the candidate beliefs they entertain. Should student groups produce models that do not lead them to the intended candidate beliefs, the final presentation and discussion serves as a forum where model results that may promote unproductive beliefs, and therefore with the potential to reinforce inequities, can be challenged by not only their teacher or project facilitator, but also by their peers.

Belief formation is still far from well understood, and the degree to which a belief is accepted and held, the factors leading to its acceptance, and even whether a belief is accepted at all, are difficult to measure. Most relevant to this study, the number of factors influencing the development of pre- and in-service teacher beliefs about the learning and teaching of mathematics, significantly complicates the challenge of isolating the source of a new belief and the mechanisms involved in its acceptance (see Figure 2).

Through the presentation and reflection in the final class discussion on the models and methods, evidence emerged that all three groups evolved in their understanding of the mathematical modeling cycle, and their understanding of mathematics for social justice. While several students were expecting to come up with a system of equations to solve, or a differential equation to analyze leading to a neat answer to a complex question, they instead found that the open nature of the problem required them to mathematize a complex issue and critically evaluate the effects of assumptions. They expressed surprise regarding the utility of mathematical approaches for addressing social issues.
As was expected by the researcher/project facilitator and the course instructor, some of the student groups (2 of the 3) relied on proportional reasoning for their mathematical model. Struggling to locate specific tracking data, they both relied on the assumption that high schools that offer calculus are schools that employ tracking, the rationales for both groups being that calculus courses only appear at the end of an accelerated or honors course track. They both gathered information available for individual schools that offer calculus from the Department of Education Civil Rights Data and compared the proportion of students enrolled in the schools, to those taking calculus, both of which were disaggregated by race. They both argued that if tracking were equitable, each student demographic would be represented in calculus courses proportional to overall student populations’ demographic makeup. One group concluded that tracking is inequitable, while the other group’s model appeared to suggest the opposite. This contradictory outcome was discussed as a class, and the differences in outcome were attributed to the possibility of flawed assumptions, which then produced contradictory results when applied to different schools.

Figure 2. Factors influencing the development of pre- and in-service teacher beliefs, and the web of existing beliefs through which they are filtered. TPP refers to the teacher preparation program in this diagram, and IST refers to in-service teacher.

In an unexpected approach, the remaining group used NAEP data plots, comparing the percent of students tracked in eighth grade to AP course participation among high school students, AP and NAEP test scores, and child poverty rates. The model was inconclusive.
Conclusions

The impact of teacher beliefs, productive or otherwise, on their teaching practice and their attitudes toward inequitable practices like tracking cannot be overstated, and the results of this study provide additional evidence for the need of a comprehensive theory of teacher belief inculcation. While the stages of belief formation may serve as a useful starting place for understanding pre-service mathematics teacher belief formation, it must be integrated with existing research into influencing teacher beliefs.

This study also suggests a number of ways in which the project we utilized can be improved. Additional, and more specific, writing prompts eliciting students’ beliefs about tracking will significantly improve the ability of researchers to gain insight into pre-service teachers’ belief formation. In particular, the project would benefit from a simple prompt following the initial description of the practice of tracking, but prior to informing students of the many teacher organizations’ statements condemning the practice, asking for their opinion of the practice. An additional reflection journal following the final social justice discussion of tracking also would provide better data on the participants’ beliefs following the project than relying solely on the action plan, as we did for this study. In addition, students were expected to locate their own data for this project so as to avoid suggesting any specific model for them to develop, but the frustration pre-service teachers experienced and expressed in located the information they sought suggests additional scaffolding or a repository of relevant data may be beneficial. Furthermore, while this project was initially designed to be facilitated primarily outside of normal class meeting time, additional meetings dedicated solely to discussing and working on the project would be beneficial, not only to alleviate students’ stresses arising from open-ended tasks like this project, but also to provide the project facilitator with additional opportunities to question student groups regarding the choice of variables and assumptions, and the limitations and implications of their models under development.

In summation, while improvements are still warranted, mathematical modeling projects appear to be a promising means of inculcating and influencing the beliefs of pre-service mathematics teachers.

References


