

A Reflective Project for Pre-Service Teachers in University Mathematics Courses

Angela Hodge, Ph.D.

Departments of Mathematics and Teacher Education
North Dakota State University
302A Minard Hall
Fargo, ND 58105

Angela.Hodge@ndsu.edu

As part of the requirements for their undergraduate degrees, pre-service secondary mathematics teachers (PSMTs) complete many mathematics courses, including a geometry course (Committee on Undergraduate Program in Mathematics [CUMP], 2004). The role of this coursework in their classroom teaching, however, is not always apparent to PSMTs (Staples & Hodge, 2006). This paper describes a study in which the mathematics instructor was able to compel the PSMTs to think about the connections between classroom teaching and axiomatic geometry throughout a semester long geometry course. As a final project, all members of the class reported on how the course would help them in their future careers. This paper serves three purposes: (a) to describe a project that can easily be integrated into university geometry courses, (b) to report on the responses from PSMTs, and (c) to discuss consequent implications for other mathematics courses populated in part by PSMTs.

With very little extra time taken from an axiomatic geometry course, the researcher was able to determine how the pre-service teachers in the course thought the axiomatic geometry course could contribute to their future teaching. This paper delineates both the description and the success of a project designed for a university geometry course. This project, however, is easily adaptable to other mathematics courses. Although not the focus of this study, it is noteworthy to state that other majors in the axiomatic geometry course such as pure mathematicians and statisticians were able to reflect upon how the class was useful in their future careers. This is important, because a mixture of PSMTs and other mathematics related majors populate the upper division mathematics courses at most, if not all, universities. Details about all of the participants are provided.

Participants

Fourteen students were enrolled in an axiomatic geometry course at a mid-sized Midwestern University during the time of the study. Of these 14 students, 9 of them were

PSMTs. The other majors represented in the class were either mathematics majors or statistics majors. Seven students had junior status and 7 students had senior status, based on course credits, at the university. All of the students in the course agreed to participate in the study making the response rate 100%.

The geometry students were placed into four groups at the beginning of the semester. These groups were randomly assigned, but the students had the option of changing groups after the first week of class. Two students switched to new groups when given the option. Each group contained at least one PSMT. They worked in these groups every day that the course met except for exam days. The following paragraphs will describe the portion of the project aimed at the PSMTs.

Role of the Researcher

The researcher was the professor of the axiomatic geometry course. However, the instructor did not know who agreed to participate in the study until after grades were assigned for the course. To make this possible, another professor at the university who was from a different department told the students about the study and collected their consent forms. After the semester was over, the other professor delivered the consent forms to the professor of the axiomatic geometry course. This was done to reduce pressure on students to participate in the study. Fortunately, all participants agreed to participate.

The researcher has a vested interest in mathematics education, and specifically in the role of content knowledge in pre-service secondary mathematics teacher (PSMT) learning. Her role as a university professor is one with a joint appointment in mathematics and teacher education. Hence, she teaches mathematics classes populated in part by pre-service secondary mathematics teachers. Her interest in the role of content knowledge in teacher learning prompted her to investigate what PSMTs felt they learned in her axiomatic geometry course, since this is one of the mathematics courses PSMTs typically complete as part of their undergraduate coursework. She explored her curiosity with the course project requirement for the axiomatic geometry course.

Project

Near the end of the semester, each group was expected to make a 45-minute presentation to the class on how learning axiomatic geometry can help secondary teachers in their classrooms. The presentations could be given in any form (e.g., PowerPoint or activity-based). The only stipulation was each group was required to create a handout to distribute to each member of the class. Specific topics taught in the course were to be incorporated to illustrate points made by each group. The relevance of the class as a whole was also expected to be apparent in each group's presentation.

Other applications of geometry and/or the history of geometry were also allowed to supplement each group's claims. The following is a list of some possible supplemental topics: (a)

plane tilings, (b) fractals, (c) development of Lobachevskian geometry, and/or (d) development of Riemannian geometry. The groups were also encouraged to examine high school or middle school textbooks to support their assertions.

In addition to their presentations, it was a requisite that the groups include a summary of their projects. This summary was required to include, but was not limited to, answers to the following questions:

1. How does the structure of the course help pre-service teachers?
2. How could the topics in this course help someone teach geometry at the middle or high school level?
3. Why is this course required of pre-service teachers as part of their undergraduate degree?
4. If you were to re-design the course, what would you do to alter the course to make it more pertinent to pre-service teachers?

These questions were targeted at obtaining the students' perceptions of *why* PSMTs should take a university geometry course to help them prepare for classroom teaching.

Results

The students in the axiomatic geometry course put together presentations and summaries responding to each of the four aforementioned questions. In addition, they backed up their responses with concrete examples from class and from the National Council of Teachers of Mathematics (NCTM, 2000) *Principles and Standards* document. In this section, responses related to the four research questions are discussed.

How does the structure of the course help pre-service teachers?

The geometry students claimed that the axiomatic geometry class was structured in a manner such that it would benefit future secondary mathematics teachers. This structure included working in groups, teaching other students, and learning in a non-lecture-based fashion. Most of the class period was utilized by students working on problems; learning from each other while the instructor moved around the room acting as a facilitator of learning rather than the bearer of knowledge. The students reported that seeing a non-traditional type of learning and teaching in one of their own mathematics courses would help future teachers be prepared for reform-oriented (NCTM, 2000) classrooms.

How could the topics in this course help someone teach geometry at the middle or high school level?

In addition to the structure of the course, the students stated in their presentations and papers that the topics in the axiomatic geometry course related to secondary mathematics. Some of these topics related directly to the secondary classroom such as Euclidean geometry. Other topics, such as projective geometry, helped the students to understand how an axiomatic system develops and how to help secondary mathematics students learn how to construct mathematical

proof. These reasons overlapped with general reasons the PSMTs thought the axiomatic geometry course was a requirement for them to complete as part of their undergraduate degrees.

Why is this course required of pre-service teachers as part of their undergraduate degree?

The PSMTs thought the course was required to help them learn geometry, a topic they may teach in the secondary classrooms, as well as develop their proof skills. One group stated that the course helped them to develop a deeper understanding of geometry and that their deeper understanding “enables us [them] to provide a better explanation of material [to their future students].” They followed this statement of examples of topics that they claimed to not think deeply about, such as what it means for two lines to be parallel. The study of non-Euclidean geometries pushed their thinking on topics such as parallel lines, which the PSMTs claimed to be valuable in their future teaching. All groups also cited general skills (proof construction) as being a reason why this course should be required of PSMTs in their undergraduate education. They thought that as future teachers they learned how to teach their students how to form logical arguments, because of the rigor of the proofs completed in the axiomatic geometry course. Although all groups of students agreed with justification that the axiomatic geometry course was a useful course for them to take and thought it would help the PSMTs in their future classrooms, they were still able to provide suggestions to improve the course.

If you were to re-design the course, what would you do to alter the course to make it more pertinent to pre-service teachers?

The suggestions provided by the groups were ones that related to the structure of the course (problem based versus lecture based). Although the PSMTs appreciated and commented on the fact that it was important that they worked in groups, they sought more individual accountability. The students stated that they wanted some of the homework to be completed by individuals. It should be noted that over half of their exam grades came from individual exams. However, the students wanted this standard format to be part of their homework responsibility as well. They thought this would help future teachers be held more accountable for daily proofs independent of their group’s success. They also thought this would help the PSMTs understand the material better in the long run. An elimination of group homework was not suggested. Rather it was suggested that students were assessed individually at times other than the exam. The professor thought this was also a great idea to incorporate in the future. The other suggestion made by the geometry students was for the professor to provide more of a lecture style introduction to the material. This may be due to the fact that for most of these students this was the first time they were learning in such a reform-oriented manner. All other suggestions were to keep the class the same with group work and student centered learning, as the PSMTs claimed this class brought their education classes to life by illustrating how a mathematics course could be taught without pure lecture.

Through the student presentations and summaries, it is clear that the PSMTs were finding value in their axiomatic geometry course. It is the hope that by integrating similar projects into

other mathematics courses PSMTs will be able to articulate the value of their upper division mathematics courses.

Discussion

The axiomatic geometry project provided the students in the course, in particular the PSMTs, a way to think about and discuss how the course related to their future careers. The project and the work applied to the project address a need called for by research groups such as Conference Board of Mathematical Sciences (2001) and National Research Council (2001) to make connections between their content courses and their future teaching.

By taking the time to reflect on their experiences in the axiomatic geometry course, PSMTs were able to articulate ways the course could help them in their future teaching. A follow-up with these students during their student teaching and when they are out in the field will be conducted to find out if they actually do use the material they learned in their classrooms. The structure of the PSMTs' future classrooms will also be examined and compared to the structure of the axiomatic geometry course, since they cited the structure as being relevant for their future classroom teaching. Although modeled in an axiomatic geometry course, it is believed that the project would also be valuable in other courses.

The project could be linked to a number of upper-division mathematics courses. Integrating such projects into mathematics curriculum serves several purposes: (a) to help mathematics professors understand the future careers of their students, including PSMTs, (b) to engage students in thinking about how their coursework relates to their future careers, and (c) to provide discussion related to the relevance of abstract mathematics coursework in the classroom.

References

- Barker, W., Bressoud, D., Epp, S., Ganter, S., Haver, B., & Pollatsek, H. (2004). *Undergraduate Programs and Courses in the Mathematical Sciences: CUPM Curriculum Guide*. Washington, DC: Mathematical Association of America.
- Conference Board of the Mathematical Sciences. (2001). *The mathematical education of teachers*. Washington, DC: Mathematical Association of America.
- National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics*. Reston, VA: Author.
- National Research Council. (2001). *Adding it up: Helping children learn mathematics*. Mathematics Learning Study Committee. J. Kilpatrick, J. Swafford, and B. Findell, (Eds.), Division of Behavioral and Social Sciences and Education. Washington, DC: National Academy Press.
- Staples, M. & Hodge, A. (2006). The Formal Mathematics Training of Preservice Secondary Teachers: Perspectives From the Consumers - Do We Like What We See? Paper presentation at American Education Research Association Annual Conference, San Francisco, CA.

Dr. Angela Hodge is an assistant professor in the Departments of Mathematics and Teacher Education at North Dakota State University. She teaches mathematics courses at both the undergraduate and graduate levels. She is interested in pre-service teacher education and the role of mathematics coursework in the process of learning to teach secondary mathematics.