

## Learning Mathematics through Service Learning

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*This study describes a service learning-based mathematics course for non-math majors at a private liberal arts university in the Midwest. Thirty-six undergraduate students participated in the course and developed lesson plans from the content taught in class. Students then taught the lessons to third graders at a local public elementary school. Undergraduates wrote self-reflections that were collected after the service and analyzed. Data reveal students felt an increase in value and more confident learning mathematical concepts because of its real-world application in the community. We conclude that including a service learning component in teaching mathematics is valuable. Service learning can help students understand mathematics beyond numbers and equations and see its importance in societal reform.*

**Keywords:** non-math majors, service learning, mathematical anxiety, communication

Today many undergraduate students experience math anxiety. Math anxiety is defined as a “feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in ordinary life and academic situations” (Hopko et al., 2003, p. 648). Math anxiety is cyclic in nature. More anxious students display a strong tendency to avoid learning mathematics, which results in students being mathematically unprepared, which in turn increases their math anxiety (Nagy et al., 2010). This often leads to failure of passing the graduation requirements for a four-year bachelor’s degree (Bound, Lovenheim, & Turner, 2010) as well as avoiding STEM fields and careers. Various studies (Maas & Schloeglmann, 2009; Philipp, 2007) suggest there is connection between students’ attitudes and their beliefs in their capability to learn. Attitudes are mental concepts representing favorable or unfavorable feelings, and beliefs are perceived information about an object (Koballa, 1998). Students with favorable feelings and beliefs about a subject are more likely to act in favor of it and in turn will see more value in learning it. On the contrary, students with high math anxiety develop negative attitudes toward mathematics and hence are less likely to engage in mathematical learning. This problem has encouraged educators to consider ways to help undergraduates in mathematics courses better learn, especially those students who experience math anxiety such as non-mathematics majors.

Educators can use service learning as a tool in mathematics courses to lessen math anxiety and to demonstrate that mathematics is useful and applicable in students’ daily lives. Studies (Soria & Thomas-Card, 2014; Soria, Nobbe, & Fink, 2013) suggest service learning opportunities positively affect students’ self-confidence and sense of community responsibility. Schulteis (2013) discusses a service learning project for a non-major mathematics course at Concordia University and suggests service learning can be an “excellent way to enhance the extent of student learning” and help students develop “greater mastery of classroom material and an increase in civic values and skills” (p. 582). Here, we describe a study of a service learning-based mathematics course for non-math majors at a small, private liberal arts university in the Midwest. The approach to service learning discussed in this study is novel because undergraduate students directly applied the mathematical concepts learned in class to teaching

the concepts to elementary children. We also discuss the effect of service learning on undergraduate students' views of mathematics in particular and education in general.

### **Theoretical Framework**

Our study's approach to service learning was grounded in a feminist community engagement framework (Iverson & James, 2014; Novek, 1999). This framework embraces consciousness raising, connectedness, and empathy by centering opportunities for dialogue and reciprocal collaboration (Rojas, 2014). In this study, undergraduate students communicated and collaborated with one another and the instructor to develop effective lesson plans; they then reciprocated their knowledge-making by teaching it to elementary school students. Ultimately, our study practiced "emancipatory feminist teaching" (Novek, 1999), which allowed students to practice concepts they learned in math class while "working cooperatively for the greater good" (pp. 230-231), in this case, by raising mathematical literacy in the elementary school students through service learning and community engagement.

### **Methodology**

This study was conducted in a mathematics course at a small, private liberal arts university in the Midwest. This course is for non-math majors and counts toward undergraduate students' general education graduation requirement. This course was offered during a short-term semester for one month, Monday through Friday for 3.5 hours each day. Thirty-six undergraduate students were enrolled in the course and participated in the study. Students used the course textbook, *Heart of Mathematics* by Burger & Starbird (2012), and were provided with supplementary activities. Additionally, the course had a service learning component that counted as 10 percent of the final course grade. Three service learning activities were conducted at a local public elementary school. Undergraduate students were divided into 18 groups, with 12 groups of teachers and six groups of observers for each of the activities. This allowed each student two teachings and one observation opportunity. The course instructor helped undergraduate students develop lesson plans based on hands-on activities about topics taught in class, including laws of reflection, fractals, and symmetry and quilting. Students used class time to prepare and practice the lesson plans before going to the elementary school. Class time also was used to visit the elementary school and teach the lesson plans to about 50 third graders. Undergraduate students spent one hour with the elementary students teaching them the lesson plans while observers gave feedback after the lesson. Based on feedback, subsequent lessons were adjusted accordingly.

After each visit to the elementary school, undergraduate students were asked to write a self-evaluation and self-reflection. These were adapted from the Campus Compact's "The What? So What?? Now What??? Reflection Model" (A guide to reflection, n.d.). The WHAT component describes the event, i.e., teaching lesson plans to elementary students. The SO WHAT component examines the significance of the event in terms of classroom concepts as well as personal experiences. The NOW WHAT component reflects on future actions that relate to the "big picture" of using mathematics in the "real world."

### **Data Analysis**

We conducted data analysis from a qualitative, mixed methods approach. Drawing from Creswell's (2007) description of qualitative research methods, we articulate our analysis as a combination of grounded theory and narrative approaches. Analyzing data from a grounded theory approach allowed researchers to code the undergraduate students' self-evaluations and self-reflections according to emerging "major categories of information" (Creswell, 2007, p. 64).

Then, analyzing data from a narrative approach allowed researchers to use the emerging major categories to “re-story” the undergraduate students’ service learning experiences. This “re-storying” organized the emerging categories from the self-evaluations and self-reflections into a general framework (Creswell, 2007, p. 56) that provides overarching insights about the role of service learning in mathematics education and in reducing mathematical anxiety.

Researchers read each self-evaluation and self-reflection, paying particular attention to the language undergraduate students used to express the SO WHAT and NOW WHAT of their service learning experiences (the WHAT descriptions were similar, as to be expected). Researchers used open coding to document initial findings (codes), which are listed alphabetically (left to right) in Figure 1.

attitude	career	civic duty	collaboration	communication	community
confidence	connection	difference	diversity	education	embrace challenges
enjoy	excited	flexibility	future	growth	impact
interaction	logic	passion	patience	power	privilege
problem solving	responsibility	role models	service	tool	understanding

*Figure 1. Initial open codes. Researchers identified 30 codes from the data collected.*

Next, researchers examined the initial codes and grouped them together under four emerging categories, which are listed alphabetically (top to bottom and left to right) in Table 1.

*Table 1. Emerging categories. Researchers identified four categories emerging from the 30 initial codes analyzed.*

Emerging Categories	Codes supporting categories
Community engagement	civic duty, collaboration, communication, community, connection, diversity, education, embrace challenges, enjoy, impact, interaction, passion, power, privilege, problem solving, responsibility, role models, service, tool, understanding
Facing adversity	attitude, communication, confidence, difference, education, embrace challenges, flexibility, growth, logic, patience, problem solving, understanding
Looking forward	attitude, confidence, diversity, education, enjoy, excited, future, growth, impact, passion, patience, privilege, responsibility, role models, service
Relationship building	civic duty, collaboration, communication, community, connection, embrace challenges, enjoy, flexibility, future, impact, interaction, passion, power, problem solving, role models, understanding

Researchers then narrowed and focused these categories into three themes. These themes described the data at the latent level, or the “underlying the phenomenon” being analyzed (Boyatzis, 1998, p. vii), which for our study were students’ reactions to learning mathematics through service learning. Because of their service learning opportunities, undergraduate students [1] viewed education a more joyful, purposeful and less anxious experience; [2] became more self-aware about the role of mathematics in the world; and [3] became aware of community ties and responsibilities to community. Below, we provide representative student comments that support each theme.

### **[1] viewed education a more joyful, purposeful and less anxious experience**

- [I enjoyed] “working with others to teach them something rather than doing something for others.”
- [I witnessed] “unexpected moments of joy that this interaction brought to both the students in our class and the young 3rd grader students.”
- “What’s the point of learning anything if we don’t share that knowledge with anyone else? Knowledge should be a conversation, and that’s something you can clearly see when you are working with the kids and they understand it.”

### **[2] became more self-aware about the role of mathematics in the world**

- “[I] learned applicability of math/math communication to everyday life.”
- “In class we talk about not always having the same strategies or ending up with the same answer so I used this knowledge to be able to talk with the students about their different approaches.”
- “[I] Re realiz[ed] math can be learned and service shows a way to think outside of the box.”
- “Math is a very important thing in our world, and being able to use it in my writing could prove very important in inspiring change in the world. It is very important to embrace things that are difficult, that is how you learn and grow as a person.”

### **[3] became aware of community ties and responsibilities to community**

- “Community involvement is crucial to a well-developed future ... and my civic responsibility is to make sure no one is left behind.”
- “[S]ocietal change can happen when we communicate and help each other as we did in this project.”

Researchers used these themes and students’ supporting comments to “re-story” a framework about non-math major undergraduate students’ engagement in service learning. This framework is discussed in the Results and Conclusions section.

## **Results and Conclusion**

The framework that developed from our data speaks to the growth mindset (Dweck, 2015) undergraduate students developed and fostered as they engaged in mathematics through a practical lens of service learning. First, students expressed more confidence in mathematics communication and a better understanding of its role in society. Service learning helped them reduce their math anxiety and realize learning mathematics is an ongoing process that takes time

and practice. Second, undergraduate students found teaching through hands-on mathematical activities more applicable to the real world, which was different than prior experiences learning in a traditional university classroom setting. In this way, service learning helped undergraduate students think of math beyond numbers and equations and see the “real world” value that studying and applying mathematical concepts can have in others’ and their own lives. Third, undergraduate students reflected on becoming more aware of future generations of young(er) students; they shared hopeful statements that these elementary children would grow up to make a difference in the world because of educational opportunities like this course/study. Service learning, therefore, was viewed as an important community investment. This helped undergraduate students develop a strong sense of civic responsibility. Ultimately, our data demonstrate that service learning opportunities can transform mathematics from something scary and disconnected to a more meaningful and civically engaged area of study for undergraduate students, particularly those who do not identify as math majors.

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