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## Using Mathematics Literature with Prospective Secondary Mathematics Teachers

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**ABSTRACT** Literature in mathematics has been found to foster positive improvements in mathematics learning. This manuscript reports on a mathematics teacher educator's use of literature via literature circles with 11 prospective secondary mathematics teachers in a mathematics content course. Using survey and reflection data, the author found that prospective teachers expressed either benefiting or not benefitting from the literature circle practice in this mathematics class. Finally, conclusions and recommendations for future work are shared.

**KEYWORDS** *literature, secondary mathematics education, teacher education*

The Mathematical Association of America (MAA) in conjunction with the American Mathematical Society (AMS) recommends that prospective secondary mathematics teachers have the depth and breadth of mathematics knowledge to teach high school mathematics effectively (MAA, 2001). Traditional approaches to teaching mathematics have not yielded the desired mathematics outcomes; therefore, there are calls to reform mathematics instructional practices to engage students in the teaching and learning of mathematics. The National Council of Teachers of Mathematics (NCTM) encourages the use of literature in mathematics as a medium to address mathematics standards (NCTM, 2000). These ideas address many of the literary goals outlined in the Common Core State Standards (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). To this end, integrating literature and mathematics is in concert with national efforts to improve mathematics education and provide students with deeper understandings of secondary mathematics content knowledge. This manuscript shares my pedagogical practice of using literature as a didactical framework for a mathematics content course for prospective secondary mathematics teachers. The

following research question guided this project: How might the incorporation of literature through literature circles influence prospective secondary mathematics teachers' pedagogical thoughts about teaching mathematics through literature?

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### Research Context

While many scholars use children's literature to teach elementary mathematics concepts (for example, Burns, 1992; Hillman, 2000; Ward, 2009; Wilburne & Napoli, 2008), few scholars have done and written about this work at the secondary mathematics level. In one case, Franz and Pope (2005) highlighted activities based on children's literature from both prospective and in-service teachers alike. They found that these lesson activities grounded in children's stories provided teachers with a framework to broaden their students' understanding of mathematical ideas as well as link mathematics to real-world contexts. The books they used, however, were children's stories designed for elementary classroom use. In this current study, books designed for secondary mathematics learners were used to engage prospective teachers in this work.

Thompson (2010) reported on a mathematics-specific content literacy course in her work. The primary objective of the course was to focus exclusively on literacy strategies germane to the field of mathematics. Using concept worksheets, link sheets, reading quizzes, and other literacy strategies to promote a language-rich classroom, students developed a mathematically literate instructional repertoire. By having her students complete the course assignments (i.e., a reading assignment, a collection of literature texts and related learning tasks, and a year-long unit integrating mathematics and literature), she found that prospective mathematics teachers enjoyed learning about using literature in the mathematics classroom.

With the focus of reading/writing and mathematics serving as the driving forces behind future achievement in school and in life, the linking of mathematics and literature is paramount in classroom spaces (Bay-Williams & Martinie, 2004; Wilburne & Napoli, 2008). Consequently, calls are being made to integrate these two disciplines in innovative ways. As it stands, there are professional resources to assist educators with infusing reading and writing strategies in mathematics in meaningful ways (see, e.g., Allen, 2007; Brummer & Clark, 20008; Brummer & Macceca, 2010; Murray, 2004; Schiro, 1997). This paper recounts my experiences using literature circle teams in a mathematics content course within a post-secondary education context.

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### **Pedagogical Practice in Post-Secondary Mathematics Education**

This mathematics content course is designed to address the needs of future secondary mathematics teachers. In this course prospective teachers engage in explorations and lab activities designed to strengthen and expand their knowledge of the topics found in the secondary mathematics curriculum. Some of the learning outcomes include but are not limited to the following: broadening prospective teachers' understanding of secondary mathematics content knowledge, strengthening connections between secondary and collegiate mathematics, and making connections to other content areas. This practice of literature inclusion exposed prospective teachers to mathematics literature while simultaneously deepening their mathematical content knowledge. More specifically, prospective teachers were placed in literature circle teams whereby the literature circles were groups of prospective teachers charged with reflecting, dissecting, and presenting the mathematics-themed literature text collaboratively (Daniels, 2002).

The 11 participants for this project were prospective secondary mathematics teachers enrolled in a mathematics course. These undergraduate mathematics majors are simultaneously pursuing their teaching certification for secondary mathematics. During one class session, I shared a presentation concerning the practice of using literature to teach secondary mathematics. The literature circle intervention itself, however, was implemented during the midterm week. For their midterm projects, prospective teachers were placed into literature teams and made book presentations as literature circle teams (Daniels, 2002). Texts that were read, synthesized, and presented included: *How to Ace Calculus: The Streetwise Guide* (Adams, Thompson, & Hass, 1998), *The Joy of Pi* (Blatner, 1999), *The Number Devil* (Enzensberger, 2000), and *The Man Who Counted* (Tahan, 1993). Other portions of texts shared throughout the semester included: *Flatland* (Abbott, 2012), *Do the Math #1: Secrets, Lies, and Algebra* (Lichtman, 2008a), *Do the Math #2: The Writing on the Wall* (Lichtman, 2008b), and *Mathematicians Are People, Too: Stories from the Lives of Great Mathematicians*, Vol. 2 (Reimer, & Reimer, 1995). Taken together, all of these texts were selected because they presented mathematical concepts via different genres of literature to support mathematics instruction.

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### **Data Collection**

With this project, both quantitative and qualitative data collection methods were employed. Prospective teachers completed a pre and post Likert scale survey about their mathematics ideas with the following response codes: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree. The pre-survey was given on the first day of class, and the post-survey was given during the last instructional week of the semester. Prospective teachers were questioned about the value of mathematics in everyday life, the satisfaction of solving a mathematics problem, and their self-confidence in mathematics. Prospective teachers also responded to statements regarding reading a storybook about mathematics, infusing literature into a mathematics classroom, and designing mathematics lessons around literature.

To obtain qualitative data, prospective teachers had to submit a narrative reflection at the end of the semester. Prospective teachers did not have to respond to all four of the open-ended questions, but they were required to respond to at least two of them. The open-ended prompts posed to prospective teachers included:

- What is the important thing that you learned in this course? Explain its significance to you.
- How have your own experiences as a mathematics student influenced how you will teach mathematics to secondary students?
- How has this mathematics course been different from other mathematics courses that you have taken?
- How did the incorporation of literature assist with your mathematics learning?

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## Results

For the quantitative data, the pre and post means, the difference between the means, and the pre and post standard deviations were calculated. The pre and post means represented prospective teachers' average on each survey item while the pre and post standard deviations represented the standard deviations for each survey item. The difference between the pre and post means was calculated to determine whether there were significant changes as a result of completing the literature circle project. The quantitative results are not discussed in detail because of the small sample size. The results for the qualitative component are discussed in two broad categories: those who expressed that they benefited from the literature circle practice and those who expressed that they had limited benefits from the practice. It was difficult to sort the data into more nuanced thematic categories because of the limited sample size of prospective teachers. Nonetheless, I share snapshots of some prospective teachers' narrative reflections in both sections to help contextualize their ideas related to each category.

### Category 1: Benefits from the Literature Circle Practice

Some prospective teachers expressed benefits to including this pedagogical practice in the mathematics course. This was inclusive of the benefit to their own mathematics learning, their ideas regarding their (future) instructional practices, and their (future) students' learning outcomes. Below, I highlight some examples of prospective teachers' narratives; pseudonyms are used to protect the anonymity of the prospective teachers.

Before this class I had never considered bringing in literature outside of a textbook. Even if I had tried to bring in other pieces of literature, I would not have known where to look for relevant materials. *(Steve)*

Before the midterm projects we presented in class I wasn't exactly sure how to bring literature into the classroom besides using textbook applications. There are many more ways to incorporate literature through books that complement the text. There are books that tell a fun history of math, fictional books that tell stories through the use of numbers, and even subject guidebooks with fun stories and riddles to help students retain what they read. We need these materials in the classroom because not everyone loves math, and it's easy to forget that when you're a future mathematics educator taking mostly math classes with math lovers. *(Samantha)*

As these narratives show, there were some foreseeable benefits for using literature in the mathematics classroom. The prospective teachers shared that they were not sure how to incorporate literature outside of a traditional mathematics textbook. Samantha even explained further how important it is to use multiple types of literature to engage students who might not be mathematics lovers. In the final comment below, Brittany wrote about her experiences using her literature text in the course and how she wishes she had known about this text during her secondary schooling experiences while studying calculus. She expressed:

My group was assigned *How to Ace Calculus* for the midterm and while I was reading it I kept thinking, I wish I knew about this (text) years ago! *(Brittany)*

### Category 2: Limited Benefits from the Literature Circle Practice

In contrast, a few of the prospective teachers did not see much benefit from the literature circle practice. That is to say, the prospective teachers did not see much benefit from the implementation of the practice in its current state. To support their ideas, two prospective teachers' narratives are shared.

By the end of this class, in general, I still feel unprepared to incorporate literature into my classroom. Out of the options of books for the literature presentations, I am glad that I got *The Man who Counted*. I would use this book to build a basis for problem of the week in my classroom....The incorporation of these books did not help me get a better understanding of mathematical ideas nor did it help me learn how to incorporate literature into the classroom. *(Mary)*

Mary expressed how she felt unprepared to incorporate literature into a secondary mathematics classroom. Yet interestingly, she made reference to using the text to build a problem of the week. During our class discussion, it was shared that the literature books could be used during the course of a unit of study and that secondary mathematics teachers could include tasks as problems of the week as an example for students to synthesize the mathematics embedded within the texts. Nevertheless, Mary felt that the books neither helped her to better understand mathematics ideas nor to incorporate literature in a mathematics classroom. In another example, Beth wrote:

While the midterm literature presentations were interesting in that they introduced me to several books I may never have heard of otherwise, the presentations did not help me to see how I could incorporate the books in my future classroom in a meaningful way.  
*(Beth)*

Beth shared how interesting she thought the books were; this conjecture might have been stated because of how creative the presentations were that accompanied the literature circle texts. However, she stated that the pedagogical practice failed to showcase how this could be incorporated in the secondary mathematics classroom in a meaningful way. It seems Beth wanted more concrete examples of how to do this work. My strategy was to have the prospective teachers share presentations of the books and modify or create learning activities to make connections to secondary mathematics. In other words, my point was not to “tell” them ways of doing this work, but to allow them to explore ways to do this transformative work based on their own teaching philosophies with respect to their students’ needs. Perhaps their limited exposure to secondary mathematics classrooms or their lack of experience designing thematic units around a text might have led to such conclusions. At this point in their program, they have only created lesson plans with the assistance of their education instructors. Nevertheless, it is important to provide meaningful experiences for prospective secondary teachers to put on their “teacher hat” and model how to be resourceful pedagogues who provide and produce authentic learning experiences that connect to mathematics classrooms in meaningful ways.

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## Conclusion

This pedagogical practice incorporated literature into a mathematics content course for prospective secondary mathematics teachers. The outcomes suggest that infusing literature creates a culture where prospective teachers can think, question, and reason about mathematics teaching and learning. A limitation of this work, however, was the small sample size. In the future, mathematics teacher educators could explore cross-university collaboration to partner with colleagues from other institutions who are doing similar work to generate a larger sample size. Future research in this realm should explore secondary practitioners’ pedagogical practices who use literature in their mathematics instruction. There is much to learn from teachers who do this well at the secondary level as there is a gap in the research literature concerning this work.

Similar to Thompson’s (2010) research, future work could involve students composing a collection of literature texts with accompanying mathematics learning tasks. Prospective teachers could be charged to find literature for secondary mathematics classrooms. With these literature books, prospective teachers could produce thematic units centered on a text. An implication from one prospective teacher’s narrative would be to have the prospective teachers also submit mathematics activities that explicitly link to mathematics concepts in the text or have them paraphrase or rewrite a verbal explanation of the mathematical ideas expressed in the text. Substantive feedback on such work from mathematics teacher educators would support prospective secondary mathematics teachers in developing their own pedagogical skills.

To refine the current work, prospective teachers could also complete a beginning reflective paper. This paper could solicit their ideas about teaching mathematics through literature before completing the literature circle assignment and engaging in the course. Thus, the ending reflection paper could address the same open-ended exercises and allow prospective teachers to assess their own growth. It could also allow me as a mathematics education researcher to compare and contrast prospective teachers’ developing philosophies regarding using literature in the mathematics classroom.

This project used literature to influence prospective mathematics teachers’ content knowledge, pedagogical practices, and teaching philosophies. My hope is for mathematics teacher educators and practitioners to add to the research literature regarding the use of literature

in secondary mathematics classrooms and in post-secondary contexts. The benefits to prospective secondary teachers include strengthening literary, mathematical, and pedagogical skills. Perhaps one way to make this a reality is to do more of this work in post-secondary contexts with those who will become future secondary mathematics teachers.

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