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Is There Room in Math Reform for Preservice Teachers to Use Reading Strategies? National Implications

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ABSTRACT

This article proposes research for development and use of reading strategies in math classrooms. Pre-service teachers are provided with instruction of math specific reading strategies in a semester long content area reading class. Surveys are administered to determine level of reading knowledge before the class along with attitude surveys for indicating how pre-service math teachers perceive themselves as teachers of reading. Since math textbooks represent very specific reading challenges, it is hoped that pre-service math teachers exposed to the proposed interventions will become confident in teaching reading strategies and use them to help their math students succeed. Pod-casting is introduced as a technology component for use in evaluation of teaching effectiveness.

Math Standards

With the adoption of the original Curriculum Standards in 1989 and the Professional Teaching Standards in 1991, serious reform in mathematics was launched. Since that time, math teacher educators have been struggling to understand and implement the standards in the manner in which the National Council of Teachers of Mathematics (NCTM) Standards Writing Group envisioned the standards

(NCTM, 2000). Schools across the nation have engaged in staff development, research, university courses, and other methods to ensure teachers understand the NCTM standards. Additionally, leading math education researchers and participants who helped write the standards documents have continued to provide information and clarification on the standards (Middleton, et. al, 2004). For example, NCTM has published *A Research Companion to Principles and Standards for School Mathematics* (2003) and dedicated several of its Year Books (e.g. *The Role of Representation in Mathematics, Making Sense of Fractions, Ratios, Proportions,* and *Learning and Teaching Measurement,* etc.) to components of the standards. Finally, states have worked to align state standards to NCTM standards as required by the Elementary and Secondary Education Act (ESEA) originally written into law in 1965 (PL 89-10, 20 U.S.C. § 6301 et seq.). Despite all of this work, complaints of lack of rigor, closing the achievement gap, and improvement of the curriculum in schools are still lodged against the math education community.

Understanding the structure of the NCTM standards is tantamount to employing them correctly. In 2000, NCTM released an updated version of standards, *Principles and Standards for School Mathematics* (PSSM). The PSSM (2000) are divided into Content Standards and Process Standards. Content Standards provide information on the type and level of the content. For example, what ideas about geometry should be addressed in the following grade bands: PK-2, 3-5, 6-8, and 9-12. Content Standards provide overall standards for all students and then specific expectations for grade bands. Process Standards speak to *how* content should be taught. These standards include: Problem Solving, Connections, Reasoning and Proof, Communications, and Representations. Process Standards provide overall expectations for all students, not by specific grade bands. To effectively use the skills addressed by the Process Standards, one must understand how to reason, read, and communicate mathematically. Reading ability and reading strategies have the most implications for the Process Standards.

The Connection between Math and Reading Strategies

Recent research by Jacob, et al, (2006) reveals 92% of teachers self-report they are aware of and attempt to apply NCTM standards. However, when classroom teaching is analyzed, teachers do not teach in the *spirit* of the standards. The disconnect between what teachers believe they should be teaching and how they actually teach indicates teachers either do not understand what the standards mean or are unable to implement the standards in their teaching. The craft of applying the standards and teaching with a reformed approach means more than knowing the discipline, it means knowing mathematical pedagogy and knowing the pedagogy of learning and understanding. Teaching as the standards recommend requires more than just knowing how to work math problems. One must be able to write (represent) and communicate in both lay terms and terms of the discipline. These skills need to be utilized by teachers not only for their own mathematical work, but they must be able to teach students how to competently write and communicate mathematically using the symbols of the content along with definitions and/or vocabulary effectively. For example, Jacobs et al (2006) indicates that

problem solving is more than just changing written language to mathematical symbols. Rather, problem solving is dependent on reading the problem for understanding. Then the solver must transform the words to the correct mathematical statements, make connections between the words and the math, and finally propose a solution that is reasonable for the problem. Unfortunately, teachers often do not know how to teach these skills, but rely instead on repeating familiar phrases or following certain steps (Jacobs, 2006). Preservice teachers need to develop the strategies and pedagogical knowledge necessary to teach both content and process in order to create success in the classroom.

Reading Strategies and Content Area Classrooms

Reading strategies, a traditional approach to teaching specific reading skills, have long been accepted for use in content area classrooms (McKenna & Robinson, 2006; Rudell, 2005; Vacca & Vacca, 2002). Reading strategies are loosely defined as specific instructional methods for teaching reading subskills such as vocabulary and before-, during-, and after-reading procedures (Wood & Taylor, 2006; Zwiers, 2004). Each reading instructional strategy has a goal of improved comprehension, and as a result, a greater understanding of subject specific information. Inherent in this goal is a need for more in depth, or critical reading and the possibility of remediation ((McKenna & Robinson, 2006; Rudell, 2005; Vacca & Vacca, 2002). However, unlike the reading dense content subjects of English, social studies, and science, reading strategies have rarely been structured specifically for mathematics (Barton, Heidema & Jordan, 2002).

Mathematics content area classrooms challenge students in ways not apparent in other subjects. Math textbooks, for example, are not organized in ways most students have come to expect textbooks to be organized for secondary level courses. Definitions are presented with words, equations, and proofs. Additionally, texts include more charts, graphs, and other visual information not found routinely in other subject textbooks (Barton, Heidema & Jordan, 2002). Understanding the text is dependent upon a student's understanding of the associated mathematics concepts (Mayer & Hegarty, 1996; Schoenfeld, 1992). As a result, students reading math texts written in English are challenged to sweep visually from right to left to read explanatory text, but also up and down, diagonally, and left to right to read the math problems embedded in or presented with the text.

And when definitions and problems are read, students often need to read from the inside of a problem to the outside. Depending on the complexity of the definition or problem, this can create another layer of difficulty during the process of reading. Word problems present especially critical reading problems because not only can the problem be challenging mathematically, but students encountering difficulty with vocabulary or experiencing specific reading miscues such as word omissions never reach the level of actually working through the math—they are stuck in the process of comprehending the written information. Application of students' strategies for reading upper level math problems often complicate the issue since word problems cannot be successfully read this

way; word problems must be read and comprehended as regular text before the math computations can begin.

Research has indicated that math students who are directly taught strategies for reading math texts increased their comprehension of math problems and were better able to study from their math textbooks (Donahue, 2003; Ostler, 1997). It is unfortunate then, that content area teachers rarely teach preservice math teachers reading strategies for use in their classrooms, especially those strategies that directly relate to textbook reading (Menke & Davey, 1994; Ostler, 1997).

Furthermore, traditional study strategies such as note-taking often improve reflective understanding but are rarely introduced in mathematics classrooms (Wamsley & Hickman, 2006). Writing, another traditional comprehension enhancing strategy, has demonstrated utility in math classrooms by adding a dimension of literacy especially appropriate for low-achieving students, but once again, writing is not utilized frequently in math classrooms (Baxter, Woodward & Olson, 2005). And although frequent lip service is given to reading being emphasized across the curriculum, math is often left out of this equation (Ediger, 2005).

Content Reading Classes

Most curriculums for preservice teachers at the secondary level require students to take a one semester content area reading course. Instructors of content area reading classes strive to instill the fundamentals; however, future teachers often do not realize the importance of the class until faced with problem readers, slow readers, and nonreaders in their content area classrooms. And frequently, future content area teachers feel that someone else should teach reading—the English teacher or reading specialist, for example (Draper & Siebert, 2004; Vacca & Vacca, 2002). Research has indicated that a semester of exposure to reading strategies in a content area reading class may be insufficient for preservice teachers to feel competent in application of this knowledge (Draper & Siebert, 2004; Hall, 2005). Preservice teachers indicated that they *may* teach reading as a result of a content area reading class, not that they necessarily would. Although attitudes towards reading instruction generally improve as a result of the class, preservice teachers rarely develop the confidence or knowledge base necessary for reflective application. While not every preservice teacher sees herself as a reading teacher conclusively after a one semester course, an improvement in attitude is often significant for transfer from knowledge to practice in the classroom (Dieker & Little, 2005; Hall, 2005). Awareness is an important aspect of this attitude shift.

Two concerns that are critical for preservice teachers to be aware of are learners with disabilities and high stakes testing (Dieker & Little, 2005). Content area subjects are frequently taught through lecture and individual reading; learners with disabilities and low reading students struggle in classes using these methodologies exclusively. Reading strategies have traditionally been used to bridge the gap and create ways to remediate low reading students and provide structured support for learners with disabilities (McKenna & Robinson, 2006; Rudell, 2005; Vacca & Vacca, 2002). The other area that preservice

teachers need to have heightened awareness is how reading affects high stakes testing. As exit tests are becoming more common for high school graduation, the need for competence in reading becomes even more important in every subject. Each exit test is also a reading test for specific content areas.

Most secondary classroom teachers believe that the transition from *learning to read* to *reading to learn* is accomplished by students at the secondary level (Draper & Siebert, 2004). This belief exacerbates the problem of instilling the need for secondary teachers to teach reading along with the content subject. The need for direct links between classroom research and future practice is critical. And as a result, the National Council for Teachers of Mathematics's (NCTM) Research Committee has issued this specific challenge (Heid, et al., 2006). More research is needed to accomplish the dual challenges of linking research directly to practice and therefore providing content area teachers with research conclusions and methodologies that directly impact student learning in regard to reading in content area classrooms. Connections between math and reading are possible. However, minimal research between these connections has been done. Review of the research brings out few connections other than teachers doing small experiments or pondering the possibilities (Hall, 2005; Heid, et al., 2006).

Technology Use in Classrooms

As standards-based instruction becomes more prevalent, teachers will have to look to this research to illustrate how to accommodate the use of technology in each content area. Both the NCTM and the National Council for Teachers of English (NCTE)/International Reading Association (IRA) standards incorporate technology as an alternate delivery method for course content and for student application of content information (National Council of Teachers of English, 1996**;** NCTM, 2000). One way to apply these standards is through ipod technology. As the use of ipods become more mainstream in academia, video ipods used for preservice teachers to record, review, reflect, and get peer input on lessons given in actual content classrooms is an innovative way to use this technology (Abram, 2006; Booth, 2006; Lum, 2006; Flanagan & Calandra, 2005). And while the cost of technology is never a non-issue, the cost of ipod technologies is considerably below other technology systems, and as a result, has been used for many classroom applications by both teachers and students (Adeniji, 2006; Anderson, 2005; Borja, 2006). Also, given that teachers and their students have been successful in creating video podcasts and forms of coursecasts, ipod technology becomes attractive regardless of technology experience (Eash, 2006; Lum, 2006).

In 2005, Mississippi State University (MSU) initiated the MSU Podcasting Pilot Project. Faculty were encouraged to become part of the project if they were interested in learning about podcasting and its academic applications. The Information Technology Services Department at MSU provided faculty with support and flexibility in applying podcasting technology to their classrooms. Selected classroom computer consoles were fitted with podcasting devices so that professors could podcast lessons simultaneously during class or record for later access. Portable recording devices were also used to

record students and faculty outside of the classroom. Faculty discovered the versatility and affordability of podcasting, and as a result, the project has been extended for further development.

One professor participating in the project, from the College of Education, had students in a secondary Language Arts Education methods class podcast mini-lessons as designed by Lucy Calkins (1994). Technology support at MSU has created a system which allows instructors to easily upload podcasts such as these mini-lessons immediately after class. Students were then able to access these podcasted lessons through iTunes or the MSU website. This gave students the opportunity to listen to their own or other students' lessons. Students who participated in this project were then required to write a reflective review of their lesson, self evaluating their presentation in terms of student impact, design, and oral performance.

The technology component of this assignment enhanced enthusiasm for these lessons and provided students with a direct and easily accessible way to reflect on their budding performances as teachers. In a continuation of this plan, the next step will be to initiate video podcasting in the second level of this class, methods of teaching Language Arts. In this, the capstone class for pedagogical methodologies required for all content areas, students are required to spend 30 hours in a local classroom under the direct supervision of an experienced classroom teacher. During this practicum, students are required to become the primary instructor for a least two full periods of the class. As a continuing part of the MSU Podcasting Pilot, this course is targeted for video podcasting. Students will be required to use the same self evaluation process with the inclusion of the visual component. In addition, a process of peer review will be added since the technology enables students to easily access all recordings.

The use of ipods for technology inclusion has been chosen for this proposed project. As in the MSU Pilot Project, preservice teachers will be able to record lessons they present in classrooms during field placement, review these lessons, and evaluate their own performances and the lessons presented by their peers. Lessons will be presented in math classrooms and will focus on applying reading strategies. Review of these lessons along with classroom assessments will be used to evaluate the application of reading strategies and their impact on student learning.

Proposed Project

The purpose of the research is to determine if increased instruction on using specific reading strategies in the math classroom significantly impacts a) the type of reading-specific instructional strategies used by preservice teachers in their own classrooms during field placement, b) the awareness of preservice teachers of mathematics of their roles as content reading teachers and understanding of reading issues as related to mathematics. Three questions have been developed as the research begins:

1.) Does the academic performance of preservice teachers increase in a proof-based math course when specific reading strategies are used?

2.) Does specific content reading instruction change the attitudes of preservice math teacher towards the importance of reading in the math classroom?

3.) Do preservice math teachers significantly increase the application of reading and writing in their field placement classrooms after specific content reading instruction?

The treatment group will have intensified reading training in the content area reading class. Additionally, specific reading strategies will be discussed in the math methods courses. The work of the treatment group will be compared to the work of preservice students who did not receive the same instruction. The treatment group of students will also complete math reading and writing assignments in the Foundations of Geometry courses required of all preservice math education students. For the investigation, each preservice teacher's work will be compared to work of non-education majors.

Specific surveys administered at the beginning of content area reading course, end of course, and end of math methods course have been chosen for portions of the research. A repeated measure test will be used to determine if math education preservice teachers attitudes about using and teaching reading strategies in the math classroom change significantly after specific instruction. One component of this inventory will be whether or not preservice teachers begin to see themselves as teachers of reading.

Inventories have also been chosen to determine how well preservice teachers calibrate their knowledge of content area reading; in other words, preservice teachers will be asked to approximate their knowledge and confidence in teaching reading. Scores on each inventory will determine actual knowledge versus perceived knowledge. Rubrics have been previously developed and will be revised for the purposes of this research. Student presentations recorded and reviewed via ipod will be graded with a rubric to determine their knowledge of and ability to use reading strategies and supplemental information. A mixed methods approach will be utilized to answer each research question.

Writing-intensive proofs, which require use of definitions, postulates, theorems, and writing mathematically, will be focused on during the Foundations of Geometry class. The course instructor will use a rubric to grade the resulting work. Matched subjects will be utilized for pairing math education students with traditional math students to analyze the scores on the proofs. A rubric will be developed to determine the student's ability to apply and make connections to the math process standards and the development of lessons. Finally, the Teacher Candidate Assessment Instrument used by Mississippi State University will be used to determine each candidate's effectiveness in teaching reading specific lessons in supervised math classrooms. Interviews will be completed with each candidate after the completion of these lessons. A focus group consisting of all math education students will be held at the conclusion of student teaching.

Concluding Remarks

In conclusion, reading across the curriculum is not a new concept, neither is the idea of reading in content areas. However, very little research provides math educators guidance in how to apply reading strategies in the mathematics classroom. Therefore, research efforts of both math education specialists and reading specialists will be needed to provide the reading strategies that will most impact the students' ability to use the unique reading methods required for mathematics. The research framework presented in this article attempts to meld the knowledge of both reading and math to begin the critical work of improving reading in mathematics.

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