EFFECTS OF IMPLEMENTING CONTENT-AREA READING STRATEGIES IN A SECONDARY MATHEMATICS CLASSROOM

by

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SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN EDUCATION AT NORTHERN MICHIGAN UNIVERSITY

November 26, 2013

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DATE: December 1, 2013
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Abstract

Reading permeates every subject in our school system. Problems with reading comprehension hamper learning in all subjects. The purpose of this review of literature was to understand the barriers to the implementation of content-area reading strategies, understand ways to overcome those barriers, and highlight strategies that are effective in the secondary classroom. Special attention in each of these topics was given to teachers of mathematics. After a review of the literature, recommendations were made for the improvement of content-area reading instruction including a re-thinking of pre-service teacher preparation, a call for focused professional development for in-service teachers, and specific strategies for use in secondary classrooms. Also suggested was future research of content-area reading strategies in secondary mathematics classrooms.
Chapter I: Introduction

Reading is one of the most fundamental skills a child learns. Reading plays a part in every classroom, every day. All teachers must be prepared to teach reading, no matter what their content area. The introduction to this literature review will cover the current problems with content-area reading instruction, the causes of those problems, and ways to improve reading outcomes for students.

Background and Statement of Problem

The problems with current reading and mathematics instruction in the United States are staggering. When tested, 27% of eighth grade students across the nation perform below the basic achievement level in math (National Center for Education Statistics, 2011a), and 24% of eighth grade students across the nation perform below the basic achievement level in reading (National Assessment of Educational Progress, 2011b). According to ACT (2013), 56% of high school graduates are not ready for college-level reading and mathematics courses. In addition, approximately 40% of high school graduates lack the literacy skills sought by employers (Peter D. Hart Research Associates, 2005). Other students have difficulty completing high school. Each day, 6,000 more U.S. high school students become dropouts (Editorial Projects in Education Inc., 2012).

Content-area reading instruction is a major part of this problem. Math instruction has moved away from repetition and memorization and towards helping students develop a deep understanding of mathematical processes and concepts. The shift in mathematics instruction has highlighted a need for increased literacy instruction in the mathematics classroom. As Draper (2002) found, “Literacy instruction is inseparable from meaningful math instruction” (p.523). The National Council of Teachers of Mathematics found in their Principles and Standards
(2000) that “students who have opportunities, encouragement, and support for speaking, writing, reading, and listening in mathematics classes reap dual benefits; they communicate to learn mathematics, and they learn to communicate mathematically” (p. 60). When our schools are studied, researchers reveal almost no classroom time (less than 3%) is spent on reading comprehension instruction in content-area classes (Durkin, 1978; Ness, 2009). Even with the increased need for literacy instruction in mathematics, teachers often face many stumbling blocks in implementing the needed instruction. Teachers may feel more responsible to teach content than reading or may feel unprepared to offer specific reading instruction due to a lack of knowledge (Ness, 2009). Poor preparation of pre-service teachers by content-area literacy courses or a teacher’s prior feelings towards reading may also have an effect on classroom reading instruction (Akyol & Ulusoy, 2010). The purpose of this review is to examine the literature about content-area reading and draw conclusions about what can be done to improve content-area reading instruction in schools.

**Theoretical Framework**

Reading is a complex process which requires interaction between reader and text. Central to this process is the theory of metacognition, which describes an interaction between knowledge, experiences, tasks, and strategies (Flavell, 1979). Metacognition can be simply thought of as thinking about thinking (Hiebert & Raphael, 1996). Literacy instruction in mathematics needs to focus on “constructing meaning, building connections, and developing understanding” (Siebert & Hendrickson, 2010, p. 42), which requires the use of strategies in a discipline-specific way. Students need to be taught reading strategies and when specific strategies would be most useful.
Research Questions

As part of this literature review, three research questions are explored:

1. What are the barriers to content-area reading instruction?

2. What can be done to increase the use of content-area reading strategies by pre-service and in-service teachers?

3. What effective reading strategies are used in secondary mathematics classrooms?

Defined Terms

**Literacy.** Literacy is defined as the “ability to negotiate and create texts in discipline-appropriate ways or in ways that other members of a discipline would recognize as ‘correct’ or ‘viable’” (Draper & Siebert, 2010, p. 30).

**Comprehension instruction.** Comprehension instruction is defined as when the “teacher does/says something to help children understand or work out the meaning of more than a single, isolated word” (Durkin, 1978, p. 488).

**Reading comprehension.** Reading comprehension is defined as "the process of simultaneously extracting and constructing meaning through interaction and involvement with written language” (Snow, 2002, p. 11). These terms were chosen for definition because a deep understanding of these key terms is fundamental to an understanding of the research that follows in the literature review. The definitions help the reader to understand ideas being discussed and specific research that was done.

Summary

Reading instruction is a huge problem in today’s schools. One of the main elements of this problem is a lack of content-area reading instruction, especially in mathematics. Reasons for this lack of instruction range from teachers who do not believe reading instruction is important to
pre-service teachers who are ill-prepared to teach reading to their students. Whatever the cause of this lack of instruction, it is something that needs to be researched, and conclusions need to be drawn about effective approaches to fix the problem.
Chapter II: Review of Literature

Reading instruction must be looked at on many levels. The focus of this literature review will be content-area reading because reading pervades every minute of the school day for students across the world. The learning of content-area reading strategies begins before a teacher has received his/her certification and continues throughout his/her teaching career. This review will study the barriers to effective content-area reading instruction in the secondary classroom for both pre-service and in-service teachers. The review will then delve into how to overcome the barriers to content-area reading instruction. Lastly, research on strategies shown to be successful in the secondary classroom will be examined, with emphasis on strategies used in a mathematics classroom.

Barriers to Content-area Reading Instruction

Barriers for pre-service teachers. Final years of university instruction can have a deep impact on the teaching practices of new teachers. In respect to content-area reading instruction, almost all education students in the United States attend a class specifically tailored to content-area reading. In total, 37 states have some form of a content-area reading requirement before certification (Come Romine, McKenna, & Robinson, 1996). Although many states may require a reading course for undergraduates, researchers have revealed these courses may not have a positive effect on attitudes of pre-service teachers regarding reading and reading instruction.

Attitude towards reading. When surveyed about their attitude towards the teaching reading in content areas after participating in a required content-literacy course, 90 pre-service teachers showed no significant difference in their feelings. The mean score of the group actually decreased from 79.65 to 79.58. Researchers concluded the content-area reading course did little
to enhance attitudes of pre-service teachers towards reading, and nothing to increase the personal reading or writing of the pre-service teachers (Nourie & Lenski, 1998).

One of the reasons a content-area reading course may have little effect on the attitudes of pre-service teachers is because the attitudes have become cemented through the years of school that teacher has gone through prior to college. In a study of 124 secondary pre-service teachers, Daisey (2009) found that teachers identified as have low reading enjoyment were less likely to have as a teaching goal to be a positive reading role model or to expect teachers from their content area to be readers. Pre-service teachers with low reading enjoyment were also found to be less likely to see the rationale for a content-area literacy course, both at the beginning and at the end of the semester.

In a study of 114 pre-service teachers, Lesley (2011) found that teachers were inclined to repeat the literacy experiences of their prior schooling. The teachers enjoyed reading at home but could not connect that enjoyment to reading at school. Assessment of reading ability was seen by the teachers to be the same for everyone and focus on standardized tests. The teachers also saw struggling readers as “incapable of improving” (p. 29) and specific literacy strategies as objects to be used only by struggling readers. The teachers also described rarely being given a choice in what they read, and being limited in their writing responses. Lesley, Watson, and Elliot (2007) found that the poor attitude of some pre-service teachers towards content-area reading came their viewing of all reading in their content area as being textbook reading. The pre-service teachers read to complete assignments and not to expand their knowledge or enjoyment of their content area.

The reasons behind the poor attitudes towards reading instruction of some pre-service teachers have varied sources, including the following:
• Constraints of the workplace.

• The sub-culture of their content area.

• The feeling that reading should be the domain of an English teacher.

• Reading not being the preferred method of instruction.

• Content-area reading being seen as common sense.

• Content-area reading strategies not being compatible with content learning (O’Brien & Stewart, 1990).

**Sub-culture of mathematics.** The sub-culture of mathematics has an especially large effect on the use of literacy strategies. In a study of the literacy messages available to teachers, Siebert and Draper (2008) found that the basic definition of text and literacy tend to devalue the tools used in the mathematics classroom. Mathematics teachers often use graphs, equations, tables, and symbols to convey meaning instead of relying on words alone. The literacy messages also suggest that teachers use technology that adolescents are familiar with to expand an adolescent’s literacy use out of school. However, these messages do not give specific examples to help mathematics teachers be able to expand an adolescent’s out-of-school literacy while staying true to the discipline. Mathematics teachers are often urged to use strategies that are not a logical fit within their discipline, and they are asked to use literacy and reading in ways that are not authentic within the discipline. Using reading or writing activities that are not common in the discipline of mathematics (newspaper articles, stories, biographies) will not help students in their mathematical understanding and misrepresent how mathematics is communicated in real-life. It is not surprising that mathematics pre-service teachers go into teaching with little regard for common content-area literacy strategies.
The sub-culture of a content area also seems to play a role in which reading strategies a teacher uses in their own reading. In a study of 505 pre-service teachers, a significant difference was found in the amount of reading strategies used by math and social studies pre-service teachers with math teachers using fewer strategies. The belief of the pre-service teachers was that math courses “do not require students to have a good reading skill” (Akyol & Ulusoy, 2010).

Cooperating teacher. The cooperating teacher (classroom teacher responsible for a pre-service teacher) also has a large effect on a pre-service teacher. Because a pre-service teacher may feel the classroom in which he/she practices to be his/her workplace, the constraints of the workplace include what a pre-service teacher feels comfortable implementing in the classroom of a cooperating teacher. Researchers found pre-service teachers who were working in classrooms of cooperating teachers first checked the initial climate of the classroom and made sure any strategies implemented were compatible with the classroom climate and the discipline of their content area. In a study of ten pre-service teachers, the cooperating teacher was found to be the most dominant factor in the use and selection of reading strategies for classroom instruction (Bean, 1997).

Each study of pre-service teachers has limitations. A study only looks at a small number of teachers from a small area of the country. Nonetheless, findings of these studies are all significant. If reading instruction in schools is to improve, attention needs to be paid to pre-service teachers.

Barriers for in-service teachers. Barriers pre-service teachers face regarding content-area reading can also be found when looking at research on the practices of in-service (practicing) teachers. In-service teachers who were surveyed identified themselves as content-area teachers and not as reading teachers, much the same as pre-service teachers. In-service
teachers felt ill-equipped to teach specialized reading skills and felt pressure to get through all of their state standards (Ness, 2009). In another study of in-service teachers, 68% of participants expressed severe doubts about their ability to teach students with difficulties in reading (Chambers Cantrell, David Burns, & Callaway, 2009).

Even when in-service teachers are trained in content-area reading practices, barriers to implementation still exist. Less than half of in-service teachers surveyed were familiar with the majority of current reading strategies. Many of the in-service teachers who were familiar with current reading strategies noted they did not use those strategies in their classrooms (Spor & Schneider, 1999). In a study of in-service teachers in a range of content areas, only the math teachers were skeptical of their role as literacy teachers. The math teachers felt that literacy strategies were irrelevant to their instruction and either did not implement strategies or modified strategies to use on a selective basis (Chambers Cantrell, David Burns, & Callaway, 2009).

Selective implementation by mathematics teachers could stem from the different way that they engage with texts in their discipline. Math teachers often emphasize close and repeated reading so students can make sense of domain-specific vocabulary and the precise ways in which processes and examples must be read. This is different from the ways a chemistry or social studies teacher may approach a text in their discipline (Shanahan & Shanahan, 2008). Focus now shifts to how reading instruction can be improved in the face of these multiple barriers.

**How to Overcome Barriers to Content-area Reading Instruction in the Classroom**

**Overcoming barriers for pre-service teachers.** Due to the barriers some pre-service teachers face regarding content-area reading instruction, changes need to be made to improve content-area reading courses currently offered at universities. To improve pre-service teachers’ enjoyment of reading, a course could assign pre-service teachers to read a book for pleasure and
talk about the experience with classmates. Often college students have been students for so long they believe content reading is done only to complete an assignment. Pre-service teachers then carry that idea into the classroom and this can damper the enjoyment of reading their students may naturally have.

*Examples in multiple disciplines.* Examples of reading in specific content areas should be shared so pre-service teachers are exposed to numerous ways to inject literacy into their content area. Individuals who often put up the most barriers to content-area reading are teachers who teach subjects that do not historically use reading to learn content. Teachers need to see any subject can be enhanced by having students read relevant literature. Gaining this understanding will not only allow all individuals to participate in a content-reading class, but will also allow all class members to take new ideas into school districts.

Along with reading from specific content areas, lessons that use a specific strategy should be modeled in each content area so pre-service teachers see reading strategies are not limited to certain disciplines (Nourie & Lenski, 1998). Once again, this strategy allows all individuals to participate in the content-area reading course and also may show pre-service teachers which strategies are better suited to their content areas.

*Talking about anti-reading feelings.* Barriers that hinder pre-service teachers must also be explicitly talked about in a content-reading course. Pre-service teachers should be made aware of the anti-reading culture they may find themselves in. Pre-service teachers need to know why they are teaching a topic a certain way and how the textbook may not always be the best way to convey information (O’Brien & Stewart, 1990). The best way to face barriers is by open discussion so the barriers do not follow a pre-service teacher into the classroom.
Overcoming barriers for in-service teachers. If reading instruction in content areas is to be improved, teachers must be comfortable using reading strategies in their classrooms.

Professional development. Professional development structured to combat the notion that content-area teachers are not reading teachers has been found to be effective. Structure of professional development is important because the strategies that are introduced need to focus on learning of content through reading, not just be an add-on for the teacher to implement. When a specific reading strategy was introduced as central to content learning, teachers had a deeper understanding of how the strategy was implemented and were able to help their students use the strategy to become metacognitive (Wilson, Grisham, & Smetana, 2009). The focus on content allowed teachers to more competently use a reading strategy because they were focused on a way to improve instruction inside their content area.

Professional development utilizing collaborative study groups were found to add to content learning (student scores on open-ended questions increased 16.2%), increase self-efficacy, and increase the ability of a teacher to stay with a reading strategy for the long-term. The collaborative study group succeeded because each strategy used was discussed by everyone so all teachers could see how the strategy would be beneficial to students. Teachers also continued to use a specific strategy long enough for students to get sufficient practice and opportunities for independent application. Teachers were able to support each other and overcome their fear that reading instruction would take too much time away from coverage of standards (Thibodeau, 2008). Follow-up teacher supervision after initial instruction on a new reading strategy, and continued encouragement of teachers by teachers have also been found to improve attitudes of in-service teachers towards use of content-area reading strategies (Dupuis, Askov, & Lee, 1979).
Overcoming barriers for mathematics teachers. It is important to note that a teacher’s current instructional goals and practices must be taken into account when planning professional development. In a two-year study, Adams and Pegg (2012) found that math and science teachers may need more intensive professional development to shift their instructional practice. Although teachers attended summer workshops on reading strategies and were given time to create lessons using those strategies to implement in the classroom, many teachers were only able to use the learned strategies to rehearse and revisit content. Even when a lesson had the goal to deepen understanding, the reading strategy was sometimes used improperly. Teachers of these disciplines may need help shifting time allotments for activities, connecting ideas and strategies, and using discussion to help create lessons that develop deeper student understanding.

Carter and Dean (2006) found that math teachers specifically may need direct training on decoding and comprehension strategies. In analysis of 72 hours of lessons during a summer remediation course, the researchers found that out of 101 instances of reading instruction, only two instances were decoding strategies, while 29 were comprehension strategies.

Draper and Siebert (2004) performed a collaborative inquiry study on the effect of collaboration between a mathematics and literacy teacher. The researchers found that a new model may be necessary in a mathematics classroom to promote learning and increase teacher comfort with literacy strategies. Both the mathematics and literacy teacher needed to find a shared perspective that was built through trust. By each sharing their thoughts through open dialogue, the teachers were able to notice similar instructional goals and discuss ways that literacy was already being taught in this mathematics classroom. This shared perspective allowed the math teacher to be more open to implementing reading strategies and the literacy teacher more able to suggest strategies that would be appropriate for the mathematics discipline.
Reading instruction in content-areas can be improved with structured professional development that focuses on improving content learning, collaboration, and encouragement. If content-area reading instruction is to be improved, professional development of in-service teachers must change.

**Content-area Reading Strategies and Effectiveness**

The research on effective, specific reading strategies in secondary classrooms is sparse. Because every district and classroom is different, many reading strategies may be the right ones to use. As covered earlier, the way professional development is structured has an effect on the outcome, no matter which specific strategies are used. Focus of this section will be on strategies researched in the secondary classroom, although many other strategies can be successful.

**Reciprocal teaching.** Increasing student assessment scores and comprehension should be the aim of any reading strategy. Reciprocal teaching is a combination of smaller strategies where students generate questions, summarize, attempt clarification of confusing words or text, and predict what might happen next as they read (Alfassi, 2004). This strategy is especially transferrable to science and social studies classrooms where students can apply the strategy in pairs or after reading silently as individuals. The strategy was found to increase scores of seventh grade students in science (p < .001) and social studies (p < .01) by 40% (Palincsar & Brown, 1984). Reciprocal teaching can be easily combined with direct explanation, where the teacher explains the reasoning and thought process that occurs when one reads text. The teacher explicitly states the strategy being taught and when the strategy will be used. The combination of reciprocal teaching and direct instruction was found to create a significant improvement in assessment scores for secondary students (Alfassi, 2004).
Thinking aloud. Another useful strategy to use during reading is thinking aloud. Thinking aloud has students restate, backtrack, and demand relationships while reading. Similar to direct instruction, students are taught to look for opportunities to use the thinking aloud strategies and which strategies are most useful in which situations. When modeled and explained, thinking aloud has a significant effect on reading comprehension (p < .0001). Once mastered, thinking aloud can be done on an individual basis during silent reading (Bereiter & Bird, 1985).

Mathematics strategies. As mentioned previously, mathematics teachers find content-area reading strategies least useful. As such, any strategies easily transferrable to a mathematics classroom to improve student understanding or comprehension should be emphasized. A review of the literature found four effective strategies that can be used in conjunction with one another. Say Something is a strategy in which one student partners with another student and stops at predetermined points to discuss confusion, make connections, and put text in their own words. Cloning an Author is a strategy in which students stop reading whenever they choose and pick main ideas to jot down on note cards. Once the cards have been written, students use the cards to create a concept map that can be adapted as they read. The third strategy is Sketch-to-Stretch, which has students draw meanings they gleaned from text and discuss their drawings with other students. The final strategy is called Enacting and has students create their interpretation of the text. The combination of these strategies allows students to create meaning orally, in writing, in drawing, and through action (Borasi, Siegel, Fonzi, & Smith, 1998).

Graphic organizers can also be used on their own to increase comprehension and problem solving ability. Braselton and Decker (1994) found that when a graphic organizer was modeled and students were led to guided and independent practice, students showed improvement in
problem solving. The organizer gave students a framework for a problem, required them to slow down to think about given information, and let them see other ways to solve the same problem when grouped together.
Chapter III: Results and Analysis Relative to the Problem

Pre-service and in-service teachers both face barriers to implementing content-area reading strategies in secondary classrooms. Consequently, overcoming those barriers require different actions. Mathematics teachers face special barriers in their discipline that deserve consideration. Lastly, even with all the barriers present, there are strategies that have been found to be effective in mathematics and other content areas.

Barriers to Content-area Reading Instruction

Barriers for pre-service teachers. Pre-service teachers face a specific list of barriers to content-area reading instruction. Pre-service teachers were found to base their ideas on content-area reading instruction on the prior reading and school experiences. The teachers were unlikely to view reading as enjoyable and more likely to see reading as a way to simply complete school work. These factors made the teachers less likely to desire to be reading role models and understand the need for a content-area reading course (Lesley, 2009; Lesley, Watson, & Elliot, 2007; Daisey, 2009). Creating a culture where reading is seen as enjoyably and useful to content learning is made much more difficult if university courses on content-area reading are not creating teachers who enjoy reading and serve as reading role models.

Mathematics sub-culture. The sub-culture of mathematics has a particularly detrimental effect on the use of content-area reading strategies. Research found that the discipline of mathematics required a new vision of text and literacy in order to meld with currently popular reading strategies and consequently, that pre-service mathematics teachers were unlikely to use reading strategies in their own reading. The discipline of mathematics requires specific reading strategies that allow for interaction with non-traditional text such as graphs, tables, equations, and symbols. If the strategies suggested to math teachers do not respect the different types of
texts present in the math classroom, the teachers are unlikely to adopt the strategies. In the end, the teachers may believe that reading strategies take away from their instructional goals and are irrelevant to their teaching (Siebert & Draper, 2008; Akyol & Ulusoy, 2010).

**Constraints of the workplace.** The barriers of any content area can be magnified for a pre-service teacher by the real or perceived constraints of the workplace. Cooperating teachers were found to be the deciding factor in the use and selection of reading strategies and were listed as a barrier to content-area reading instruction. The climate created in a classroom dictated whether or not a pre-service teacher would risk using a particular strategy. In this way, certain reading strategies were never attempted due to the influence of the cooperating teacher. This severely limits the experience of the pre-service teacher in using a variety of strategies and the ability to fine-tune lessons to be used in a future classroom. Pre-service teachers also limited their use of content-area reading strategies because they did not feel the strategies fit with how they were expected to teach in their discipline. In-service teachers in a district have a great power to set the climate for a discipline based on their use or lack of use of content-area reading strategies (Bean, 1997; O’Brien & Stewart, 1990).

**Barriers for in-service teachers.** In-service teachers also face many barriers to implementation of content-area reading strategies. Many content area teachers felt unequipped to teach specialized reading skills and to help students who struggle with reading. This is due to the fact that many reading strategies are modeled for use with students who do not struggle with reading and never modeled after being adapted for a struggling reader (Ness, 2009; Chambers Cantrell, David Burns, & Callaway, 2009). Just as problematic are findings that many teachers who are aware of reading strategies fail to implement them in the classroom. This is due to a gap in modeling of specific reading strategies in each content area. Teachers must see a specific
strategy as useful to improve content learning in their discipline and not a drain on their limited
time and resources (Spor & Schneider, 1999). Research also shows that teachers of mathematics
face even greater barriers than other content areas.

**Mathematics reading skills.** The different reading skills emphasized in mathematics class
often require different strategies than other content areas. These strategies may not fit general
reading strategies championed by a school district and cause mathematics teachers to perceive
literacy strategies as irrelevant to their discipline. This severely limits the strategies tried in the
mathematics classroom and perpetuates the idea that mathematics can be learned without the use
of reading strategies (Shanahan & Shanahan, 2008; Chambers Cantrell, David Burns, &
Callaway, 2009).

**Overcoming Barriers to Content-area Reading Instruction**

**Overcoming barriers for pre-service teachers.** To overcome the barriers to content-
area reading instruction for pre-service teachers, research shows reading strategies should be
modeled in numerous content areas so teachers see there are numerous ways to convey ideas
through a variety of texts and strategies. Teachers also have to be made aware of any personal
anti-reading feelings they may harbor that would limit their effectiveness as reading teachers in a
content-area classroom. Modeling a variety of strategies helps teachers see a rationale for using
reading strategies in their content area, increasing the likelihood that a teacher will try a new
strategy. Making teachers aware of their own anti-reading feelings will allow teachers to begin to
view themselves as teachers of reading as opposed to students of reading. The more that teachers
are able to face and overcome their anti-reading feelings, the more likely they are to value
reading and be a reading role model for their students (O’Brien & Stewart, 1990, Nourie &
Lenski, 1998).
Overcoming barriers for in-service teachers. Professional development has been found to increase reading strategy use by teachers. To be effective, the professional development must introduce a reading strategy as central to content learning, and teachers need to use a strategy long enough for both the teacher and students to get comfortable with its use. By crafting the professional development so that strategies are connected to content learning, teachers are given a rationale for using a content-area reading strategy that fits with their emphasis on content learning. Putting support in place after the professional development is finished was shown to increase the amount of time teachers stayed with a reading strategy, therefore increasing student comfort with a strategy (Wilson, Grisham, & Smetana, 2009; Thibodeau, 2008).

Overcoming barriers for math teachers. Math teachers were found to need more intensive professional development to shift current practices that may not include reading strategies. Specific strategies to be highlighted include comprehension and decoding. Vocabulary instruction was the main type of reading instruction given by math teachers, which limits the strategies students are exposed to and use to expand their knowledge of mathematics (Adams & Pegg, 2012; Carter & Dean, 2006).

Collaboration between math and literacy teachers. Collaboration between mathematics teachers and literacy teachers that results in a model that gives equal standing to text and mathematics was also found to increase reading strategy inclusion. During the collaboration, text and mathematics must be given an equal standing in the classroom because “they are invariably intertwined in a mathematics classroom” (p. 953). The mathematics cannot take place without text, while the mathematics determines what text is used and how it is understood. Adopting this new model for the mathematics classroom helps to expand what is thought of as text in the classroom and expands the power of text to understand and communicate mathematics. In order
to fully take advantage of the new model, both mathematics and literacy teachers must discuss what they value in instruction and the best instructional practices to achieve that goal (Draper & Siebert, 2004).

**Effective Strategies for Content-area Reading Instruction**

To assist in overcoming the barriers in content-area reading instruction by secondary mathematics students, specific strategies need to be highlighted that have shown gains in student learning in mathematics or similar content areas.

**Reciprocal teaching.** Reciprocal teaching has been found to improve scores for science and social studies students, but could be used in a mathematics classroom. The strategy has students help clarify confusion as they read and generate questions which will help students as they encounter new vocabulary in mathematics or wonder what will happen when given information changes. Reciprocal teaching was found to be most effective when combined with direct instruction that explicitly stated what strategy would be used (Alfassi, 2004; Palincsar & Brown, 1984).

**Mathematics strategies.** For mathematics students, research has shown the strategies of Say Something, Cloning an Author, Sketch-to-Stretch, Enacting, and graphic organizers to be most effective. These strategies allow students to make connections and draw their own meaning from text that they read. The strategies allowed students to develop a framework to solve problems and create meaning in various ways (Borasi, Siegel, Fonzi, & Smith, 1998; Braselton & Decker, 1994).
Chapter IV - Recommendations and Conclusion

Content-area reading success for secondary students is instrumental to their academic success. As students get older, the amount they are asked to read and comprehend increases, along with the difficulty of the text. Content-area reading strategies are necessary to help students comprehend these more difficult texts. When our schools are studied, researchers reveal almost no classroom time (less than 3%) is spent on reading comprehension instruction in content-area classes (Durkin, 1978; Ness, 2009). This lack of time spent on reading instruction parallels an alarming trend when our students are assessed. When tested, 27% of eighth grade students across the nation perform below the basic achievement level in math (National Center for Education Statistics, 2011a), and 24% of eighth grade students across the nation perform below the basic achievement level in reading (National Assessment of Educational Progress, 2011b). According to ACT (2013), 56% of high school graduates are not ready for college-level reading and mathematics courses.

A review of the literature on content-area reading strategies for secondary teachers found that teachers face a variety of barriers to proper implementation of content-area reading strategies, including previous experiences, discipline norms, personal beliefs, and student ability. Teachers of mathematics are often the most unenthusiastic to implement reading strategies, so they require specific attention. In order to overcome these barriers, thought must be given to how teachers are taught, and how new ideas are introduced to teachers currently in the field. Lastly, specific strategies must be found that allow content-area reading instruction to occur in discipline-appropriate ways.
Recommendations for Pre-service Teacher Instruction

Because pre-service teachers are still students, the barriers that they carry in regards to content-area reading instruction need to be attended to so they can become teachers of reading as opposed to simply students. To overcome these barriers, schools should tailor their teacher education courses to highlight examples of reading in a variety of content areas. This allows pre-service teachers of subjects such as mathematics to see ways to inject text and literacy into their subject areas and see reading instruction as relevant to content instruction. Also, specific lessons that use a strategy should be modeled in different disciplines so the pre-service teachers begin to see that a strategy can be modified to better fit with a discipline’s way of interacting with text (Nourie & Lenski, 1998).

Recommendations for In-service Teachers

In-service teachers need to be given well-structured professional development to help them overcome the barriers they face in regard to content-area reading instruction. Strategies introduced through professional development need to be shown as central to content learning (Wilson, Grisham, & Smetana, 2009). To improve the ability for teachers to stick with a specific strategy for the long-term, professional development should utilize collaborative study groups. This allows teachers to discuss the benefits of a specific strategy and support each other in a strategy’s continued implementation (Thibodeau, 2008). Follow-up is a necessary component of professional development to help teachers feel comfortable with a strategy and improve their overall attitude towards content-area reading strategies (Dupuis, Askov, & Lee, 1979).

To help improve the attitudes of in-service mathematics teachers, collaboration should be used between the math teacher and a literacy teacher. This collaboration helps to shift a mathematics teacher’s idea of what constitutes text and literacy and opens a dialogue about what
mathematics and literacy teachers value in instruction and how best to reach both of their instructional goals. Continued collaboration can help mathematics teachers begin to see examples of literacy instruction in their teaching, and can help literacy teachers see ways that increased literacy instruction could be used to improve content learning (Draper & Siebert, 2004).

**Recommendations for Specific Strategy Implementation**

Strategies used in secondary content-area classrooms work best when the strategies complement the way a discipline engage with text. Research on content-area reading strategy has shown specific strategies to be most effective in different disciplines.

To increase student scores, especially in science and social studies, teachers should implement reciprocal teaching (Palincsar & Brown, 1984). Reciprocal teaching is a combination of smaller strategies where students generate questions, summarize, attempt clarification of confusing words or text, and predict what might happen next as they read (Alfassi, 2004).

Thinking aloud should be used as a strategy to increase comprehension of a text in any content area. Thinking aloud has students restate, backtrack, and demand relationships while reading. Students are taught when each thinking aloud strategy will be most effective (Bereiter & Bird, 1985).

For mathematics, a total of five strategies have been shown to improve comprehension. Say Something allows student partners to discuss confusion with a text and make connections at pre-determined stopping points. Cloning an Author has a student write main ideas down on cards and use those ideas to create a concept map. Sketch-to-Stretch has students draw meanings they make from a text and discuss those drawings with others. Enacting has students create their own interpretations of a text. The combination of these first four strategies allow students to create
meaning orally, in writing, in drawing, and through action (Borasi, Siegel, Fonzi, & Smith, 1998). The fifth strategy, graphic organizers, can be used to help students with problem solving. The organizers help students create a framework to solve a problem and think about given information (Braselton & Decker, 1994). Each of these strategies attend to the specific way that mathematicians engage with text and allow students to increase their engagement with mathematical content.

**Areas for Further Research**

Based on my review of the literature, further research needs to be done on the effect of specific strategies on the learning of mathematics for secondary students. A study I would like to conduct would continue the research of Slater, Graves, and Piche (1985) who studied the effect of structural organizers on the recall and comprehension of ninth grade students while reading expository texts. They found that students who were given a structural organizer and outline grid before reading an expository text recalled 77% more idea units than the control group and performed 19% better on a multiple-choice test than the control group. I would like to try and replicate their research on reading passages specific to secondary mathematics to find a discipline-specific reading strategy to be used by secondary mathematics teachers.

The subjects of the study would be secondary mathematics students. The students should be selected from varied locations and school environments (rural, suburban, urban). I would choose to replicate the methods of Slater, Graves, and Piche (1985) and create four treatment groups. The first would receive a structural organizer and outline grid. The second would receive only the organizer. The third would only be instructed to take detailed notes. The fourth group would serve as the control.
The methods of data collection and analysis would also follow from the study by Slater, Graves, and Piche (1985). The students would then read pre-selected mathematics selections, be asked to provide a written recall of the section. A multiple-choice test would also be given to measure comprehension of the written selection. A pre-test would also need to be given to provide a baseline for mathematics knowledge on the subject. The written recalls would be analyzed for ideas that “contained a verbatim or a recognizable paraphrase of content words” (p.195) and a number of recalled ideas would be created. The number of ideas would then be run through a four-way analysis of variance to check for statistical significance. The multiple-choice tests would be scored and analyzed statistically.

Further research could also be done in various mathematics courses, to determine if the type of mathematics increased the effect of the structural organizers. The research could also be combined the research done by Bereiter and Bird (1985) which showed that modeling and explanation was the best vehicle for teaching reading comprehension strategies. However, due to the increasing amount of variables that would occur, that research may have to be done independently with a single strategy.

Summary and Conclusion

A review of the literature pertaining to content-area reading instruction in a secondary mathematics classroom includes a variety of topics. Content-area reading must be explored to settle on definitions and to develop an idea of the history of reading instruction in various content areas. The barriers to proper content-area reading instruction need to be explored, both in broad terms and specific to mathematics classrooms. Because of their differing nature, the barriers of pre-service and in-service teachers must be looked at separately. The same is true for the ways
that each group overcomes these barriers. Lastly, specific strategies for the different content areas must be looked at for their effectiveness, and their adaptability to mathematics classrooms.

The barriers to proper implementation of content-area reading instruction are vast and far-reaching. Any focus on improving content-area reading instruction will need to begin by breaking down these barriers by using research-tested strategies. The attitude of teachers towards reading instruction should be the first barrier that is attended to. This could be done with teacher self-assessment or through administrator-led professional development.

After reviewing the literature, I conclude that there are gaps in the literature pertaining specifically to secondary mathematics reading instruction. More research needs to be done on specific strategies to be used in a secondary mathematics classroom. Research on strategies that are successful in other content area should be extended to test their effectiveness in mathematics. Strategies that are successful in mathematics should be highlighted to increase the knowledge of mathematics teachers in regards to reading instruction in mathematics. Increased knowledge is the first step to increased implementation of strategies and increased student learning through reading in mathematics.
References


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