**"But I teach math!" The journey of middle school mathematics teachers and literacy coaches learning to integrate literacy strategies into the math instruction**

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There was a time mathematics teachers focused on teaching the subject matter and nothing else. If teachers understood the symbols, models, proofs, and the language of the mathematical strands, they would be considered "a good teacher." Increasingly, there is recognition that reading instruction needs to be part of mathematics instruction (Burns, 2006; Fuentes, 1998; Meaney & Flett, 2006). Part of this recognition is that test results of the National assessment of Educational Progress (NAEP) have only fluctuated slightly in recent years (National Center for Educational Statistics, 2003). Only 32 percent of eighth graders have attained a "proficient" level on reading scores leaving many children who are not as fluent in reading material, making inferences, and thinking critically as teachers expect or would like (Richardson, Morgan & Fleener, 2006). NAEP results and increased emphasis on standards have focused attention on the need for literacy instruction to permeate every grade and classroom.

What is it that makes math so difficult to read? First it is important to realize that mathematics is a "language" all its own. The reader needs to understand the symbols that represent mathematics concepts just as a reader must understand how letters represent sounds. They must also be able to understand syntax (sentence construction or word order) of a mathematical "sentence" just as one must understand the syntax of English, if that is the language that is being read/spoken. Fuentes (1998) argues that unlike other text where authors elaborate their points, each word and symbol in mathematics text must be read and understood with precision. In short, reading in mathematics is dealing with two languages simultaneously.

Another difficulty is the vocabulary of mathematics. Often words that are common in the English language may have a different meaning in mathematics, referred to as "overlap" by Barton and Heidema (2002) such as "plane", "difference", "odd", or "radical". A number of middle school literacy coaches expressed these ideas; "I was surprised how many of the words had a different meaning in math. I never thought of that before. As a literacy specialist I never looked at math as its own language until we sat down and really looked at it."

Text structure is also a challenge. Mathematics writing is succinct. Each sentence often contains a lot of information with little or no redundancy and often contains text and numerals or symbols (Kenney, Hancewicz, Heuer, Metsisto & Tuttle, 2005). The organization and structure of it is different from the texts that most students learn to read from, and very few are taught in explicit and direct ways how to read it. Math textbooks tend to contain varying sidebars that include reviews, definitions, historical facts, real word connections or practice questions. (Barton & Heidema, 2002; Kenney et al., 2005). This kind of writing is difficult to read for those who are proficient readers, but even more daunting for those who struggle.

By teaching all of the students the unique demands of mathematical texts and ways to deal with them, they should improve in their ability to do and communicate their mathematic understandings. Adding to the difficulties for struggling readers and writers, teachers trained as content specialist do not have extensive training on how to teach the higher level language and literacy skills or special needs [strategies](http://findarticles.com/p/articles/mi_qn6207/is_20041016/ai_n24908177/?lc=int_mb_1001) which are needed in today's classrooms (Richardson et al., 2006). One middle school literacy coach explained, "We are experts in our field not experts in content." A lead math teacher concurred by stating, "As a math person I didn't think literacy was all that important in my classroom. I didn't see the big relationship. They were kind of at opposite ends of the spectrum." This article provides a description of a project designed to address these realizations and ways in which [math teachers](http://findarticles.com/p/news-articles/chattanooga-times-free-press/mi_8094/is_20090903/math-teacher/ai_n50917877/?lc=int_mb_1001) and literacy coaches could work together to improve the mathematics and literacy skills of their students.

So, how do you get teachers to focus on mathematics and literacy? A joint project between a high need urban school district and Niagara University created a [professional development](http://findarticles.com/p/articles/mi_qn5305/is_20090501/ai_n31629415/?lc=int_mb_1001) opportunity that allowed this idea to be explored. Funded through a grant from the US Department of Education, professional development was offered to middle school teachers to help them develop their own understandings and expectations of both literacy and mathematics and to help them to link classroom activities to the high-stakes tests in New York State.

The project had two distinct phases. The first phase encouraged the teachers to discuss their concerns about their students and their learning needs and to define their goals. The second provided guidance and resources to help them develop strategies and resources that they believed would assist their students and improve their own teaching of mathematics and literacy.

Phase I was a new concept for these teachers and professional development. Most of their experiences with professional development required attending workshops whose topics and goals were identified by administrators or professional development teams. This project used a constructivist approach, allowing them to determine their own course for development. This process took time as they decided what their concerns were, what their questions were, and how they wanted to investigate them.

The teachers were in teams that included both mathematics teachers, literacy specialists and special education teachers which proved for very thoughtful and interesting discussions. One of the math teachers expressed that "early on (she) had her doubts." As the conversations developed, the groups decided that they wanted to investigate the literacy skills and strategies that were needed to successfully complete the state 8th grade mathematics exams. The teams worked to create a list of mathematics skills and literacy skills and tried to determine which literacy skills would most help students in their understanding of math and the application to the exams.

Examining the state 8th grade mathematics exam led to new appreciation for the need to think about literacy in mathematics. Working in their teams of math teachers and literacy coaches, the teachers examined the following structure and organization:

1) presentation of questions

2) vocabulary

3) the format in which the answers needed to be represented

For example, all groups reported that the test included various "structures" students needed to read including tables, various types of graphs and charts, multiple part questions, and graphic organizers. Many of the teachers recognized that the vocabulary of the tests was at a higher level than the students could read independently. Examining the tests from a literacy point of view became an "ah ha" moment for many of the teachers. They knew these structures existed but had not thought about what skills and understandings students needed in order to read and understand each of these text features. One literacy coach said "At one point while examining the 8t grade exam I realized the challenge of [the] language and [knew that] without vocabulary instruction kids wouldn't do well."

Once teachers created a list of vocabulary, structures, and math skills they moved into Phase II, but not before there was much complaint and confusion. The process was "messy" to say the least and it was an approach that they had never taken before. It was difficult for the professors guiding the process to stay out of it. One said "I felt as if I should have been doing more. I felt guilty when I did not intervene while at the same time, I felt guilty if I did. I was very conflicted." It took half the school year to come to the point where the teachers knew what they wanted to do but this exploration was crucial to their ownership of the next phase.

Phase II was the development and application phase. It was during this time that we identified Teaching Reading in Mathematics (Barton & Heidema, 2002) as a resource that proved very helpful. As the teachers looked at the skills that were necessary for their students to have successfully complete the mathematics exam, they reviewed the recommended practices offered by Barton and Heidema. The suggested methods included such things as a think aloud to aid students in understanding how to think through a problem or process, the use of graphic organizers, using roots to determine unknown words, understanding varied formats, understanding directional words, and giving students to practice the skills in small groups. In the larger context teachers learned to consider the strategic reader, the climate of instruction, text features which include vocabulary and text styles, and how to help students with vocabulary development, understanding informational texts, and various reflection strategies. A math teachers exclaimed, "I really liked the book and was amazed to find out that I do many of these things. It confirmed strategies I use and gave me new strategies to try. It was good to know that you do not always need something new but sometimes we just need confirmation on the strategies we do use."

During the application phase, teams of teachers created mini-lessons specific to the content they need to teach but imbedded the suggested practices they had explored from the readings and discussion of Teaching Reading in Mathematics. Literacy specialists had knowledge of skills and strategies but never thought about the connections to, and the impact on, content mathematics instruction. One strategy was using pre-reading strategies. For example: scanning text for unknown words, creating the K-W of K-W-L-W charts, or identifying prefixes and roots. Many textbooks bold vocabulary words they feel students will need to be introduced to. These teachers found that some of their students had other words they did not know either due to their reading ability or unfamiliarity with a term. For example, one teacher asked her sixth graders to scan a page focusing on analyzing graphs in their math textbooks looking for unknown words. The authors had not bolded any words as new terminology. Most students in her class identified "compressed" as unknown word. The textbook was discussing drawing valid conclusions from graphs. Not knowing a break in the scale of a graph indicated the scale had been compressed might have caused misunderstandings as the lesson continued. In this case the teacher was able to quickly remind students what compressed meant and provide a couple of examples.

As they developed these lessons and their understandings both mathematics teachers and literacy teachers looked for opportunities to use what they had learned in both formal and informal contexts. The mathematics teachers focused on the standards and the literacy specialists looked for opportunities to integrate appropriate literacy strategies. As the lessons evolved the mathematics teachers began to see more and more literacy opportunities on their own. A sixth grade mathematics teacher shared how she "assumed that middle school students can all read. Now I realize some kids are low [ability] and we can use content to teach reading skills." The literacy specialists also began to view mathematics differently to see how their knowledge was relevant to it. "I never looked at math before and I found I need to," one literacy coach shared.

Toward the end of the project, teachers were encouraged to try some of the lessons they had developed. Some were field tested in the classroom while literacy coaches and other math teachers observed. Others were video taped so they could all debrief. They wanted the lessons to be useful and tied to the math content. They also wanted to be sure they were modeling good reading strategies. One teacher tried a "read aloud/think aloud" strategy as she worked though a problem. She was nervous at first but when it was done she thought "it went well." The video tape confirmed it when she saw how engaged the students were and how they implemented the strategy she taught. It is also important to note that the teachers "wanted the lessons to be useful not in "addition to." In other words, they did not want to add to the already existing curriculum by having to teach literacy skills and strategies separately. They wanted them to be part of a mathematics lesson.

One team outlined a mini lesson on using prefixes. They realized students did not apply knowledge of prefixes from English Language Arts to mathematics. Thinking of units on polygons, this team recommended a 10 minute mini-lesson that would help students use prefixes to determine meanings of words. They suggested possible words such as bi, quad, penta, tri, octa, deci, di, and hexa. There were four steps in this team's procedure:

1) teacher will model several examples that go with the unit such as tri-triangle-trinomial

2) pair students with an example word so they can determine the meaning,

3) have each team report on their example word

4) add the words to the word wall

This pair recommended this literacy strategy be used when introducing new vocabulary.

As the teams worked on lessons and making connections they began to realize that not only was their job to teach children mathematics and literacy skills and strategies, but it was also their job to help their students make connections between them and to help them transfer these skills and strategies to other content areas. By helping teachers become aware of the existence of these so called "dots', they could begin to better help children see the connections and increase their skills or comprehension. This awareness was important to them because, as one teachers expressed, "How can I connect dots if I don't even know they are there?" This project helped them to begin to see that they could transfer many of the techniques and they could be generalized to other content areas. In the end increased teacher awareness resulted in increased student awareness. As teachers worked as a team and students worked as a team they all became more aware and thoughtful about their knowledge and their practices. They also became more reflective and this translated into teachers and students becoming more collaborative.

The result of this project was apparent in the growth of the teachers' confidence, mathematics and literacy knowledge, and their enthusiasm to continue their journey of discovery and exploration. Plans are being made to expand their opportunities through summer professional development and the continuation of the project to allow them to create, field-test, and evaluate integrated lessons and assess the impact of their efforts on mathematics and literacy test scores.

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