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School mathematics reform, constructivism, and literacy: A case for literacy instruction in the reform-oriented math classroom

Incorporating literacy instruction with mathematics lessons can improve students' ability to learn and understand.

(pp. 520–529)

For over 75 years, literacy educators have admonished secondary teachers, including mathematics teachers, to infuse the regular teaching of content with literacy instruction (Moore, Readence, & Rickelman, 1983). However, despite the continued call for literacy instruction across the curriculum, secondary teachers have been reluctant to take up the cause. O'Brien, Stewart, and Moje (1995) posited that traditional teaching practices that represent a transmission model of teaching and learning may conflict with the teaching and learning models supported by literacy educators. Therefore, teachers, especially mathematics teachers, may regard methods advocated by literacy instructors as incongruent with those prescribed by educators and colleagues in their field. However, with calls for mathematics reform, teachers have been challenged to change the way they teach. The reform movement may offer opportunities for literacy educators to help math teachers combine literacy instruction with the regular teaching of mathematics while accomplishing the goals set forth by school mathematics reformers.

With the newest wave of reform, some mathematics educators have called for teachers to move away from teaching by telling (the school mathematics tradition) and move toward the constructivist teaching paradigm (Grant, 1998; Noddings, 1993). While not specifying a constructivist paradigm, in the *Principles and Standards for School Mathematics* (*Principles and Standards*) the National Council of Teachers of Mathematics (2000) called for a more student-centered math classroom that deemphasizes rote memorization of isolated skills and facts and emphasizes problem solving and communication, whereby students can gain mathematical power.

This new kind of mathematics classroom is very different from the traditional one. Teaching practices that are typical of the school mathematics tradition have been recommended by and for math teachers as the most efficient and effective way to deliver instruction. Marquis (1989) outlined a daily plan for teachers to help them best use their time and suggested that the plan would increase the passing rate in first-year algebra. Her plan very closely matched that described by Gregg (1995) as the school mathematics tradition and relies on what others have called a telling pedagogy, pedagogy of control, or the transmission model of instruction (O'Brien et al., 1995)—daily review of previous assignment, development of new material, checks on students' understanding (by working a few examples), seatwork, and homework assignment. However, reformers believe that the rituals of the school mathematics tradition have made it difficult for students to recognize and use mathematics in their lives (Cobb, Perlwitz, & Underwood-Gregg, 1998).

Mathematics reformers hope to challenge the beliefs and routine of the school mathematics tradition in order to help students gain meaningful, lasting, and useful mathematical knowledge. Teachers, however, have had a difficult time transforming their classrooms under the latest wave of reform (Smith, 1996). Constructivism as a theory of learning can provide the framework needed to help math teachers move from a transmission model to one in which the learner and the teacher work together to solve problems, engage in inquiry, and construct knowledge.

Constructivism is one theory of learning and human growth among several (e.g., feminism, sociocultural, critical theory, social interactionist) that mathematics teachers can embrace to help transform their classrooms. I have chosen to focus my discussion on constructivism because it represents the learning theory and perspective that has been central to the research reported in mathematics education journals in recent years (Cobb et al., 1998; Noddings, 1993; Simon, 1995; Zazkis, 1999). Furthermore, constructivism is cited in math methods textbooks (Brumbaugh, Ashe, Ashe, & Rock, 1997; Cangelosi, 1996; Posamentier & Stepelman, 1999) used to prepare secondary mathematics teachers. Therefore, constructivism represents an established and recognized theory, albeit one of several, to which many educators ascribe.

My goal in this article is to locate the common language and goals of mathematics educators and literacy educators. It is my belief that a constructivist paradigm, while problematic at times, represents the best avenue for open, meaningful, and comprehensible dialogue between mathematics educators and literacy educators. I describe here the goals and nature of school mathematics reform and the philosophy and nature of the constructivist classroom. I also suggest that math teachers, who are interested in creating reformed classrooms, can look to constructivist theories of learning and content-area literacy theories and methods to provide the structure needed to make reform happen in their classrooms.

School mathematics reform

While one could argue that educational reform has been ongoing since formal education began, the latest round of reform in mathematics began with the publication of *A Nation at Risk* (National Commission on Excellence in Education, 1983). It really got underway with the publication of the *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989; see also Grant, 1998) and continues today with the recent publication of the *Principles and Standards* (National Council of Teachers of Mathematics, 2000). Mathematics reform has worked to move instruction away from the tradition in which knowledge is viewed as discrete, hierarchical, sequential, and fixed and toward a classroom in which knowledge is viewed as an individual construction created by the learner as he or she interacts with people and things in the environment (Grant, 1998; Noddings, 1993). Reformers are aiming to educate students (generate understanding) rather than to train them (produce specific performances) (Battista, 1994), and this requires a very different kind of classroom than the traditional one.

Proponents of reform in mathematics believe that "'knowing' mathematics is 'doing' mathematics" (National Council of Teachers of Mathematics, 1989, p. 7). Therefore, reformers are pushing for classrooms that encourage students to act and think like mathematicians. Copes (1996) stated that mathematicians pose problems, solve problems, and analyze the solutions to problems. In reform-oriented mathematics classrooms students work in cooperative groups, they use manipulatives to help them model problems and solutions, they work on projects that require them to think about interesting problems for longer than a typical 50-minute period, and in doing so students construct their own mathematical knowledge (National Council of Teachers of Mathematics, 1989).

Smith (1996) posited that reform in the mathematics classroom has been hindered by practices that undermine teachers' sense of efficacy. He pointed out that the traditional approach to math instruction enables teachers to build a sense of efficacy by "(a) defining a manageable mathematical content that they have studied extensively and (b) providing clear prescriptions for what they must do with that content to affect student learning" (p. 388). Because proponents of school mathematics reform prescribe neither content nor method of instruction, math teachers may feel less sure of what it is they should teach and less capable of employing methods to teach it. Smith suggested that teachers do the following:

- expand problem choice to include problems from a variety of situations that are part of students' lives now, not just in the future;
- continue to be experts in their content fields so they are able to predict student reasoning;
- give students opportunities to express themselves through mathematical discourse as they work to construct and refine their mathematical thinking;
- balance students' constructions with selective, judicious telling in order to help them gain terminology;
- model mathematical ideas; and
- assist students in their mathematical reasoning.

However, despite this advice, mathematics teachers are still left with a blurry view of how to create a math classroom that invites inquiry, initiates students' questioning, and provides students with the opportunity to explore and discuss as they construct their mathematical understanding.

Constructivism

Many proponents of mathematics reform have advocated a constructivist perspective of teaching and learning (Cobb et al., 1998; Noddings, 1993; Simon, 1995; Zazkis, 1999). Constructivism is the philosophy, or belief, that learners create their own knowledge based on interactions with their environment including their interactions with other people. Constructivists recognize (a) that experience and environment play a large role in how well the learner learns and (b) that language plays a key role in the acquisition of knowledge (Dewey, 1938/1997; Larochelle, Bednarz, & Garrison, 1998).

Constructivists rely on teaching practices that are rich in conversation. Through these conversations, the teacher comes to understand what the learner is prepared to learn (wants to learn) and how to orchestrate experiences and more conversations so that the learner is able to construct meaning, understanding, and knowledge. Constructivist teachers reject the transmission model of teaching (Larochelle & Bednarz, 1998; Richardson, 1997) or the pedagogy of control or telling. Instead, they embrace teaching methods that put students in contact with the environment, with one another, and with the teacher in order to pose questions, search resources (including themselves and one another), and propose solutions to problems.

The role of a constructivist teacher is to assist students as they create constructions. Gallimore and Tharp (1990) described the following six ways in which teachers assist their students' performance: "modeling, contingency, managing, feeding back, instructing, questioning, and cognitive structuring" (p. 177). These means can provide the structure and support necessary to move students from the inability to perform a particular task to the ability to perform it and, with repeated exposure, to the ability to perform it unassisted. Constructivist teachers observe in order to make decisions about what each learner is capable of and willing to learn. Based on these observations, the constructivist teacher creates an environment that will provide the learner with the opportunity to construct knowledge. The constructivist teacher, rather than allow the learner to wade through an experience unguided, provides opportunities for the learner to question, probe, and ponder.

While many mathematics teachers agree with the tenets of math reform in general and constructivist perspectives specifically, they may find them difficult to embrace because they represent a way of teaching and learning that is very different. In addition, constructivist teaching is not a monolithic, agreed-upon concept (Richardson, 1997). Richardson explained that "Constructivism is a descriptive theory of learning...it is not a prescriptive theory of learning" (p. 3). In other words, constructivism provides educators with a description of how it is that students (and other people) come to know and understand, but it does not prescribe what it is people should learn or specific methods for helping students construct knowledge. Furthermore, constructivist teachers in different disciplines may approach their teaching in very different ways. Therefore, how a constructivist mathematics teacher conceptualizes and approaches teaching and learning may be quite different from how a constructivist writing teacher conceptualizes and approaches teaching and learning (Richardson, 1999).

Literacy instruction in the mathematics classroom

Literacy and literacy instruction are necessary parts of mathematics instruction. Gallimore and Tharp (1990) stated that "Schools should teach students to be literate in the most general sense—capable of reading, writing, speaking, computing, reasoning, and manipulating verbal (and visual) symbols and concepts" (p. 192). Similarly, Carpenter and Lehrer (1999) proposed that mathematical understanding emerges from these five forms of mental activity: "(a) constructing relationships, (b) extending and applying mathematical knowledge, (c) reflecting about experiences, (d) articulating what one knows, and (e) making mathematical knowledge one's own" (p. 20). The mental activities described by Carpenter and Lehrer depend on the literacy skills advocated by Gallimore and Tharp—therefore, literacy instruction is inseparable from meaningful math instruction. This is supported by the *Principles and Standards* (National Council of Teachers of Mathematics, 2000): "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).

In fact, the *Principles and Standards* included a communication standard for school mathematics (National Council of Teachers of Mathematics, 2000). Specifically, the communication standard states that

> Instructional programs from prekindergarten through grade 12 should enable all students to—
> - organize and consolidate their mathematical thinking through communication;
> - communicate their mathematical thinking coherently and clearly to peers, teachers, and others;
> - analyze and evaluate the mathematical thinking and strategies of others;
> - use the language of mathematics to express mathematical ideas precisely. (p. 60)

However, despite this written standard, the authors of the *Principles and Standards* offer few suggestions on how teachers can help their students negotiate mathematics texts to create understanding.

Many mathematics teachers view literacy instruction in the classroom as simply helping students to read the textbook. Learning to read and use the textbook for learning rather than simply as a repository for problems would be an advance over the lack of literacy instruction that currently exists in the typical mathematics classroom. However, more important than learning how to read the textbook is learning how to read, write, listen, speak, and think math texts. Mathematics educators must expand their definitions of texts to include anything that provides readers, writers, listeners, speakers, and thinkers with the potential to create meaning through language (Neilsen, 1998). In so doing, it is easy to see that the mathematics classroom is a text-rich environment and students may need assistance to negotiate and *read* the various texts.

The expanded definition of text provides a new context in which to think about reading and what reading is. Vaughn and Estes (1986) defined reading as an event of "*thinking* cued by text" (p. 11). This is similar to Smith's (1994) notion that "reading *is* thinking" (p. 180). Current discussions of reading focus on how the reader creates meaning as a result of the transaction between the text and the reader (Ruddell, 1997; Smith, 1994; Vaughan & Estes, 1986; Wilhelm, 1997). These definitions expand our notion of reading from simply moving one's eyes across a page of written symbols to reading as a mode of thinking and learning (Siegel, Borasi, & Smith, 1989).

When students meet text (e.g., the mathematics textbook, a solution to an equation, a proof, or a mathematical explanation), the meaning that they create will depend largely on their prior knowledge and experience of the information or concepts that are part of the text and the kinds of thinking they do after they have read the text. Comprehension of the text happens when the reader constructs his or her meaning from the text that is compatible with the author's intended message. This depends on the content knowledge of the learner (reader) and the ability of the learner to make sense out of the signs and symbols inherent in the text. This is quite different from the notion that the text somehow carries meaning to the reader. Students in math classrooms may need assistance reading and creating mathematics texts because either they lack mathematical content knowledge or they lack an understanding of how to use and manipulate mathematical signs and symbols. Mathematics teachers, who are experts at reading and creating math texts, are in the best position to help their students engage in this kind of literacy.

Content-area literacy strategies in mathematics

With an expanded view of text and reading, mathematics teachers can look to theories and methods developed by literacy researchers to find ideas about how people think and learn and how to help students become strategic learners. Flood and Lapp (1990) outlined the strategies used by strategic readers who have learned how to read to learn. Those strategies are as follows.

Before reading, the strategic reader

- Previews the text by looking at the title, the pictures, and the print in order to evoke relevant thoughts and memories
- Builds background by activating appropriate prior knowledge through self-questioning about what he/she already knows about the topic (or story), the vocabulary and the form in which the topic (or story) is presented
- Sets purposes for reading by asking questions about what he/she wants to learn (know) during the reading episode

During reading, the strategic reader

- Checks understanding of the text by paraphrasing the author's words
- Monitors comprehension by using context clues to figure out unknown words and by imagining, inferencing, and predicting
- Integrates new concepts with existing knowledge, continually revising purposes for reading

After reading, the strategic reader

- Summarizes what has been read by retelling the plot of the story or the main idea of the text
- Evaluates the ideas contained in the text
- Makes applications of the ideas in the text to unique situations, extending the ideas to broader perspectives. (p. 490)

This information is not intended to reduce strategic reading or learning to a bulleted list of behaviors that teachers can have their students move through like calisthenics. Nevertheless, it does provide a starting point for math teachers who wish to make mathematics texts more accessible to their students. It can also provide teachers with the structure they need to help their students engage in discourses that will enable them to make meaning from (read) various mathematical texts. Siegel et al. (1989) concluded that mathematics as a way of knowing (which is supported by reformers) and reading as a mode of learning (which is supported by constructivist literacy educators) are compatible in a math classroom. I am suggesting that the two are not simply compatible, but inseparable in a constructivist mathematics classroom.

It is unrealistic or too optimistic to expect adolescents to have acquired the reading and mathematics skills necessary to read math texts without the assistance of a more informed other. (If adolescents could read the mathematics texts without assistance, one would wonder if they really needed to be in the class.) Comprehension activities designed to foster strategic reading (learning) in general can be adapted to assist students in developing strategic reading skills for mathematics. These activities can provide the script necessary for working with students in their zone of proximal development with regard to reading mathematics texts. Included in these activities are opportunities for students to become active meaning makers as they interact with text and practice some strategic reading habits as they create their own understanding.

Comprehension activities such as Directed Reading-Thinking Activity, or DR-TA (Stauffer, 1969), the Guided Reading Procedure, or GRP (Manzo, 1975), the Read, Encode, Annotate, Ponder activity, or REAP (Eanet & Manzo, 1976), the Anticipation, Realization, Contemplation model of reading, or ARC (Vaughan & Estes, 1986), and the What I Know, What I Want to know, and What I Learned, or K-W-L (Ogle, 1986), give teachers a structure with which to support learning. At the same time they work to create a student-centered, constructivist classroom. These activities and others like them (see Manzo, Manzo, & Estes, 2001) provide students with practice as they develop strategic reading skills and with the tools they need to become independent learners. The activities also encourage students to write, draw, and discuss as they work to take new perspectives, make connections to other texts and contexts, and create meaning from text, allowing students to participate in all aspects of communication.

Unfortunately, many mathematics teachers have viewed literacy instruction as a throwback to the school mathematics tradition, and because that is to be avoided it follows (through the transitive property of equality) that literacy instruction is to be avoided. Authors of math methods textbooks have discussed mathematical textbooks and their use in deprecatory terms (Brumbaugh et al., 1997; Cangelosi, 1996; Posamentier & Stepelman, 1999) and in close proximity to arguments for the rejection of the school mathematics tradition. However, literacy instruction has never been part of the school mathematics tradition, so transitivity does not apply in this case. In addition, expanded definitions of texts and reading make it clear that the math classroom is a text-rich environment, and in order for students to acquire mathematical power they must be able to *read* those math *texts*.

Comprehension activities in mathematics

The activities developed and described by literacy researchers have been discussed in conjunction with narrative texts or at least with expository text that resembles what teachers have traditionally thought of as text (i.e., social studies and science texts). Literacy researchers and educators who have not come from a mathematics background leave it up to the teachers to adapt the activities for mathematics. However, math teachers may have difficulty imagining how they might do that (Dynak, 1997). Furthermore, there are few examples in the literature describing how to adapt literacy activities for the mathematics classroom.

Consider the example of the mathematics text that appears in the shaded box in the Figure. This text is a combination of what is typically considered text and mathematics text that consists of numerals and symbols. Certainly, students may need assistance to make sense out of the standard text; however, students may need greater assistance to make sense out of the mathematics text. As in any type of text, comprehension is aided when the reader has set a purpose for reading, has made predictions about the reading, can monitor his or her own comprehension, and can summarize the information contained in the reading (to list only a few of the things strategic readers do to comprehend text). Consider the questions of how mathematics teachers can help their students (a) set a purpose for reading this text; (b) make predictions about what might be contained in this text; (c) monitor comprehension (indeed, what does comprehension monitoring in mathematics involve?); and (d) summarize the text. When mathematics teachers consider the entire list of strategies used by successful readers, the list of questions becomes much longer.

Teachers can use the DR-TA (Stauffer, 1969) to provide students with a model and practice for how to strategically read a mathematics text. In the DR-TA, the teacher begins by locating a piece of text that he or she would like students to read. Before introducing the text, the teacher can prepare students for reading by activating their background knowledge and arousing their interest (in

Strategic reading of mathematics

Set purpose: Before reading, have students attempt to solve a problem similar to one in the reading. Allow students to use any means possible to solve the problem: guess and check, make a picture, and so on. Once students have struggled with the solution, they can generate a list of things they need to know in order to find a solution. The list of things the students need to know becomes their purpose for reading the text.

Example: The following system of equations can serve as a good prereading problem. Students can solve this system using graphing (typically taught before solving by addition). However, the students will find that the intersection of the lines does not occur in a convenient location to accurately determine the solution to the system. Therefore, another method of solution is necessary.

$$2x + 3y = 3; -2x + 6y = 3$$

Predict: Before reading, and after setting a purpose, students should generate a list of *guesses* as to how the author will solve the problem.

Example:

Solve the following system of equations by the addition method:

$$x + 2y = 4$$
$$-x + y = 2$$

Solution:

If we add the two given equations, the variable x will not appear in the sum, and the sum will contain only one variable, y. Add the two equations to obtain one equation in one variable. Then solve for the remaining variable:

$$\begin{aligned} x + 2y &= 4 \\ \underline{-x + y} &= 2 \\ 3y &= 6 \\ \frac{3y}{3} &= \frac{6}{3} \\ y &= 2 \end{aligned}$$

Now substitute 2 for y in either of the original equations to find the value of x:

$$\begin{aligned} x + 2y &= 4 \\ x + 2(2) &= 4 \\ x + 4 &= 4 \\ x &= 0 \end{aligned}$$

The solution to the system is (0, 2)

(Angel & Porter, 1990, p. 348)

During reading, students should continue to set purposes for reading and make predictions. In addition, students should monitor their comprehension of the text. This may require students to pause briefly at several points while reading to ask and answer questions.

Predict: After reading the first sentence and before reading the rest of the example, students should stop and modify their list of *guesses*. In this case, students should consider how addition might be used to solve the system.

Monitor: Students should ask themselves questions to monitor their own comprehension. Questions include How will this step get me closer to the solution? Is there any part of this explanation that is unclear? Are there any terms included in this explanation that I don't understand? Does this explanation make sense to me?

Monitor: Students should continue to tie explanations to predictions and purposes by asking themselves questions like How does this fit with how I expected the author to solve this problem? or, in this case, How did the author use addition to get this equation?

Set purpose and predict: Students should continue setting purposes for reading and making predictions while reading by asking and answering the following questions: What will the next step look like (based on existing knowledge of mathematics)? What is the author going to say next?

Monitor: Does this line make sense to me? How did the author get this? Does this step fit with my prediction? How is it the same? How is this different?

Monitor: Does this set of mathematics text fit with the written explanation provided by the author? Can I see what the author is doing? Does this make sense to me? If it doesn't make sense, where did it stop making sense?

Summarize: After reading, students should be able to summarize what they read to demonstrate their comprehension. The following are ways in which students can summarize a mathematics text. Solve a similar problem (perhaps with different numbers) using the steps described by the author. Solve the problem provided before reading and solve it using the steps provided by the author. Provide a description of the steps used by the author to solve the problem either orally or in writing. Complete a graphic organizer, such as a flow chart, showing the steps involved in solving the problem.

the Set purpose section in the Figure the students work an example similar to the one found in the reading and try to solve the problem by any means possible).

Once students have worked on their problem (and some may have even been successful), the teacher can introduce the reading. The teacher should direct students to read the title of the text (in the case of the example, it would be *Solving Systems of Equations Using Addition*). The teacher would then ask students to generate a list of predications or questions they expect to be answered from the text (for example, The text will probably explain how to solve systems of equations by addition, but what will be added? How will addition be used?). Then the teacher should have the students read a predetermined amount of text (with mathematics texts, it makes sense to stop after each sentence of regular text and after each line of math text at the beginning of the activity). The teacher has the students stop reading after a small portion of the text and asks them to answer questions like What is this text about? Who can summarize what we just read? Does this information fit with what we thought the author would include in this text? How does this fit with our predictions? What information do you think the author will share next? (Notice that these are the questions that strategic readers ask and answer for themselves.) After reading, the teacher can provide activities designed to help students summarize and use the new knowledge gained from reading the text (in mathematics classes this usually means allowing the students to solve problems similar to those found in the text).

Teachers can use the DR-TA to provide students with metacognitive prompts (e.g., questions that prompt thinking about thinking) thereby assisting students while they read and learn mathematics. The idea would be for teachers to provide most of the prompts at first, as students practiced strategic thinking, and to then wean the students from reliance on them after practice in this kind of thinking. This activity fits with constructivist teaching goals in that the teacher, the more informed other, provides the students with a dialogue or a script so that they can read and comprehend a text that they would not be able to read and comprehend without assistance. This is done with the eventual goal that the students internalize the script (e.g., metacognitive prompts) and can then read and comprehend similar texts independently.

Another reading activity that mathematics teachers can adapt is K-W-L (Ogle, 1986). The K-W-L activity has three parts consisting of What I *K*now, What I *W*ant to know, and What I *L*earned. As with the DR-TA, K-W-L provides a framework within which the teacher can guide students through the kind of thinking, reading, and learning done by strategic readers. The first part of the activity (What I *K*now) is designed to help students activate their own schema and consider their own background knowledge before reading the text. The second part (What I *W*ant to know) provides students with an opportunity to set purposes for reading the text. The third part (What I *L*earned) occurs after the students have read the text and allows them to summarize their learning.

In mathematics, many students have difficulty generating a list of what they know on a given subject, because they have not yet received instruction on the topic or because they have little experience considering what they already know. For instance, with the example in the Figure, it may be difficult for students to generate a list of things they know about *Solving Systems of Equations by Addition*. However, this would not be the first lesson about systems of equations that the students encountered, and they should be able to generate a list of things they know about such systems (i.e., the solution to a system of linear equations is located at the point of intersection of the lines, and so on). Again, giving students a problem they do not know how to solve can help them generate a list of things they already know. Additionally, this problem situation can provide the stimulation to generate a list of things that students want to know or need to know in order to solve the problem. This is a tricky part of the activity for all teachers, who may encounter students who claim that they wish to know nothing. Nevertheless, with the proper stimulation and with teacher persistence, students can create a good list of questions. This list then becomes the purpose for reading the text. Finally, after the students have read the text on their own, they attempt to answer the questions that they posed before reading and add anything else they learned as a result of reading the text (e.g., I learned that solving systems of equations by addition means that you add the two equations together to make a new equation with one variable). Students then use their list of learned information to create a summary of the text.

These are just two quick examples of how teachers can adapt literacy activities for the mathematics classroom. Both of these activities provide opportunities for students to activate their background knowledge and establish purposes for reading, which is a primary tenet of the constructivist model of teaching and learning.

Creating a constructivist classroom

Constructivism offers educators a way to think about how people think and come to know. Constructivist pedagogy requires that teachers take into consideration what students know, what they want to know, and how to move students toward desired knowledge. Because what students want to learn may shift and because the experiences necessary for students to explore ideas may vary, constructivist teachers find themselves in unpredictable and tenuous situations. This kind of teaching requires a receptivity and responsiveness to students and teaching with which many teachers—especially mathematics teachers—may be neither familiar nor comfortable (Noddings, 1993; Smith, 1996). While literacy activities, which are based on constructivist theories, may not provide math teachers with the most stable and sure place from which to teach, they can provide some of the structure needed to help teachers feel competent and able as they change their teaching habits from the transmission model of teaching to a constructivist model of teaching.

Moreover, when mathematics teachers attend to the literacy needs of their students—their needs to make meaning (construct knowledge) as a result of their interactions with mathematical texts—they are doing their jobs. A mathematics education that assumes to prepare students without providing them with access to text falls short of truly educating students. Literacy activities, designed to help students negotiate and create text, can be adapted for use in math classrooms. The end benefit of these adaptations can be a mathematics classroom that is responsive to the needs of all students and falls in line with constructivist tenets of teaching and learning, engaging students and teachers in conversations around mathematical texts in a way that lets students negotiate and create these texts. This kind of mathematics learning environment reflects the kind of classroom envisioned by mathematics reformers. I am suggesting that math teachers, armed with the knowledge of the content, can use the specific methods that are part of established content-area literacy instruction in order to make reform a reality in their classrooms. It is not a matter of conceptualizing entirely new methods for teaching mathematics, but rather of incorporating the established methods described by literacy educators with math instruction.

Let me close with a paraphrase of an argument made by Yoakum (1945, p. 462) over 50 years ago. When asked, "If I teach reading, what will happen to the [mathematics]?" Yoakum replied, "The more important question is, what will happen if you don't? If the teacher is not conscious of the need for directing the reading activities in [mathematics] a great deal can and does happen to [mathematics]." As long as mathematicians pose problems, solve problems, and analyze problems (Copes, 1996), and as long as those problems, solutions, and analyses appear as text, teachers have an obligation to help their students negotiate and make meaning of the text in order to keep mathematics within the reach of all students.

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