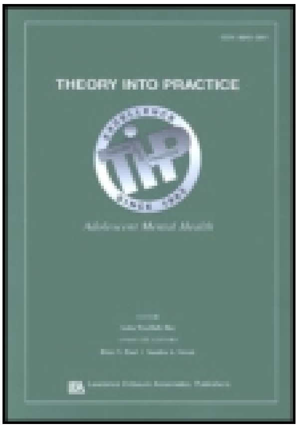

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Engaging First Graders to Participate as Students of Mathematics

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First-grade students often come to school relatively naïve about what it means to be mathematics students. Thus, first-grade teachers have the responsibility not only of teaching mathematical content to their young students, but also of socializing them into a culture of mathematics learning. In this article, the authors document both how teachers provide explicit instruction about participating in mathematics learning and how they implicitly communicate to young students what counts as appropriate behaviors for engaging in mathematics learning. The authors also discuss how these instructions and practices lay the foundation for students' understanding of how they are expected to engage in learning mathematics.

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> First of all, [the student] should love math. He cannot say, "I don't like math." That won't work for sure. So *the teacher must get him to love it.* (Correa, Perry, Sims, Miller, & Fang, 2008, p. 145, emphasis added)

THIS QUOTE CAME FROM a first-grade mathematics teacher from Beijing while we were conducting research on mathematics teaching and learning in the United States and China. If we want our young students to learn to love mathematics—to become engaged learners and also to learn mathematics—what must teachers do to foster this? More specifically, what can first-grade teachers do to socialize young students to become successful students of mathematics?

We take these questions as the focus of this article. Before explaining what we did and what we found, we first lay out why we would believe that first-grade teachers have this awesome power, and if they do, how they might harness and even exploit their power to help their students become engaged learners of mathematics.

The role that teachers play in guiding mathematics lessons seems to make a difference in how students both understand the concepts (Ma, 1999) and come to understand their role in relation to the teacher and the mathematical content (e.g., Cobb, Boufi, McClain, & Whitenack, 1997; Stigler & Hiebert, 1999; Turner & Patrick, 2004; Yackel & Cobb, 1996). In the best-case scenario, the students have a direct relationship with the mathematics (Stigler & Hiebert, 1999); it is the students who wrestle with the mathematical content (Hiebert & Grouws, 2007) and the teacher serves as a guide in this endeavor. In this scenario, the students come to own the mathematics and develop a sense of intellectual autonomy when they have struggled through a problem and reached an understanding, albeit with the guidance of their teachers.

So how do teachers serve as guides? Turner and Patrick (2004) detailed how teachers can support positive student participation in sixth and seventh grade; Yackel and Cobb (1996; see also McClain & Cobb, 2001) detailed the role teachers play in the development of sociomathematical norms that serve to give students intellectual autonomy in late elementary classrooms, allowing them to be "aware of, and draw on, their own intellectual capabilities when making mathematical decisions and judgments" (p. 437, Yackel & Cobb, 1996). But we asked what this looks like in first-grade classrooms, when students are relatively naïve about their roles as learners. To address this, we videotaped three veteran female first-grade teachers throughout the school year in a small urban (~125,000) university-dominated community. We observed three consecutive lessons in the first month of school, three in the middle of the school year, and three in the last month of school. We looked for ways in which teachers explicitly or implicitly taught their students about how to behave as students and how to learn math. In the following sections, we describe what we found.

Explicit Teaching: Instructions on Participation and Behavior

Teachers often just tell their students directly how to behave, with explicit instructions about what to do and what not to do. As Brophy (1983) put it, "Most children . . . need to be socialized into the student role. They require a great deal of formal instruction, not only in rules and expectations but in classroom procedures and routines" (p. 280). Indeed, the teachers in our sample did this often. In 20 hours of observing, we counted 639 explicit instructions, about one instruction every other minute. These instructions ranged from straightforward directions that were likely to be useful throughout the students' educational careers—such as making it clear that you need to raise your hand if you wish to speak—to those that were arguably more specific to participating in mathematics lessons—such as explaining how to collaborate on solving a mathematics problem.

We found three distinct, but interrelated, categories of instruction on participation: (a) instructions on classroom procedures, (b) instructions on how to treat each other and the materials, and (c) instructions on how to learn mathematics. Each category of instruction provides specific information to students on how to behave appropriately in mathematics lessons and we illustrate each of these, in turn.

Instructions on Classroom Procedures

Instructions on classroom procedures are very important, especially for students who are just entering formal schooling. As Brophy (1985) pointed out: "Especially in the lower grades, effective classroom managers spend a great deal of time ... explaining expectations and conducting lessons ... in the routines and procedures to be used in the classroom" (p. 236). We found that teachers gave instructions about four specific classroom procedures. These were:

- focusing attention (e.g., "You can't see if you're not turned around."),
- asking students to follow the teacher (e.g., "Are you stacking them like me? Your stacks don't look like my stacks yet."),
- letting students know they needed to raise their hands to speak (e.g., "Raise your hand if you can tell us what we worked with yesterday in math class. Anna?"), and
- asking students to speak up to be heard (e.g., "You gotta talk real loud 'cause I can't hear you.").

Comments such as these serve an important purpose: Each type explicitly directs students about how to participate successfully in the classroom and about what behaviors are acceptable. Some of these instructions were moves by the teacher to obtain or maintain order in the classroom, but others were less about control and order than about providing opportunities for students to participate. For example, students cannot follow the logic of a problem if their classmate speaks so quietly that the contribution cannot be heard. In all of these cases, teachers gave students clear directions about the rules for successful participation in their classes.

Instructions on How to Treat Other Students and the Materials

The second type of instructions centered on how to treat the other students and the mathematical materials in the classroom. We found several ways in which these instructions were instantiated:

- instructions on respecting others (e.g., "Scoot back so everyone can see" or "Excuse me, Steven is the only person talking"),
- instructions on the proper way to use tools (e.g., "Oh, I see people not using these the way they're supposed to"), and
- instructions to do one's own work (e.g., "Mary, take care of Mary. Henry, take care of Henry").

These instructions show students that respect for others and materials are important parts of the classroom experience. Without this basic respect, the enterprise of doing mathematics may be compromised.

Instructions on How to Learn Mathematics

The third type of instructions centered on learning mathematics, specifically. These instructions took several forms:

- instructions on what to look at (e.g., "So now I'm at 7. You watch what I'm going to do, OK?"),
- instructions on thinking before you act (e.g., "Take a look to see what you need to figure out in this problem"),
- instructions on the shared responsibility of the students and teacher (e.g., "Don't worry if you get this wrong because we will figure this out together"), and
- instructions on the helpfulness of working together (e.g., "Boys and girls, one of the most important things in math is learning to work together").

These instructions differ from the previous categories because they focus on how to learn mathematics, specifically, rather than classroom management, generally. In considering how teachers could form a culture of learning in their classrooms, we found these types of instructions to be most beneficial because they have the potential to give students specific insights about how their behavior directly impacts both the learning environment and how mathematical understanding can be acquired.

Explicit Teaching: Summary and Commentary

With each of these instructions, teachers were giving their students explicit directives about how to behave in their classrooms during mathematics lessons. Although some of these instructions were about keeping order in the classroom, other instructions communicated a deep respect for learning by making it clear to students that successful mathematics learning includes listening to others, having access to and focusing attention on the problem-solving materials, and working collaboratively with the teacher and other students to come to understand mathematics. The variety and frequency of these instructions suggest that teachers make conscious decisions, even if on the fly, about how to socialize their young students into becoming students of mathematics.

Teachers communicate to their students both directly, like with the instructions we have just described, and indirectly, by placing their students in the position to participate and learn in particular ways. For example, when teachers ask their students for explanations, this communicates to students both that mathematical problems can be explained and that the students are legitimate explainers. In the next sections, we describe four different classroom participatory structures that communicate indirectly to students what is expected of them as students of mathematics.

Unique Contributions

Teachers sometimes place students in the position to provide information that they, and only they, can provide. When a teacher does this, it communicates to students that their perspectives are valued and students learn that mathematics is a discipline to which they can contribute. This allows students to have direct involvement in the mathematics that takes place, and, oftentimes, they have the added benefit of seeing that mathematics is personal and happens in their daily lives. This excerpt comes from a lesson on Venn diagrams (requests for unique contributions appear in italics):

T: OK, boys and girls, listen carefully, don't move yet, don't move until I tell you. *If you ate hot lunch today, I want you to stand here* [indicating a large circle on the floor, which the teacher had constructed from string]. Don't move yet. And *if you rode the bus today, I want you to stand here* [indicating a second circle].

. . .

S: I'm curious.

T: OK, Robin said, "I'm curious." Robin, *tell me why you're curious*.

S: Because I ate hot lunch today **and** rode the bus.

This excerpt illustrates how a teacher can ask students to add personal information or their own knowledge to the creation and solution of mathematics problems. In doing so, students have an opportunity to make the mathematics personal and gain ownership of the problem being discussed. We hypothesize that this strategy helps to keep the students engaged and helps them learn the material in a meaningful way.

Multiple Students Participating

When a teacher asks for input on the same problem from multiple students, the teacher is saying something important about the process of solving mathematical problems: That there is not necessarily a single pathway to their solution. This is a vital component of participating in mathematics (Lakatos, 1976); by offering their own perspectives, students become empowered with mathematical authority, thereby enculturating them into a mathematics community (Hamm & Perry, 2002). Teachers inculcate young learners into this process by making sure that multiple perspectives are presented and multiple voices are heard. This also gives students the message, much like unique contributions, that their input matters in this enterprise and that mathematics happens in a community. This community feel is illustrated later in the same lesson, when Robin is curious about where she should stand, in the circle with the students who rode the bus or in the circle with the students who ate hot lunch, because she is the only student in the class for whom both of these statements are true. Here we see how the teacher solicits multiple students to participate in helping to resolve this issue (requests for multiple students to participate appear in italics):

T: So where should you go? OK.... Our first problem that we talked about was Robin. Robin's problem is what? Tell us again Robin.
S: I ate hot lunch and rode the bus!
T: OK. Raise your hand if you have an idea of how Robin can solve her problem. Joseph?
S: She could be like [Joseph stands wide, with a foot in each circle.]
T: She could put one foot in both. Would that work?
S: Yes.
T: OK, try that Robin. One foot in both. *Any other way that you think Robin can solve her problem?*
...
T: OK. *Juan?*
S: She could go to each one.
T: OK, how would you do that? Just keep taking turns, OK. [Juan nods] *Dustin?*
S: We could cut her in half. [Children laugh.]
T: There's a creative solution. *Uh, Lashanda?*
S: You could put both, you could put both of those circles together and she could stand in just one.

Here, we see how the teacher continued to request multiple possible solutions to the curious dilemma of Robin needing to be represented in both the set of students who rode the bus and the set of students who ate hot lunch. The students came up with several sensible and several outlandish ideas, and one student, Lashanda, also came up with the mathematically sophisticated notion that the intersection of the two sets could be represented by overlapping the two circles. By having multiple students contribute ideas, the class had the opportunity to construct solutions and to evaluate the feasibility of each of the potential solutions. This is akin to authentic behavior among mathematicians. We can see that even young students can enact this professional stance toward the discipline if teachers socialize them to think about mathematics as a community endeavor in which they have voice and authority.

Challenge

Participating in mathematical discourse often requires having your solutions challenged by others or, alternatively, challenging the solutions and procedures of others. By challenging other students, young learners are in the position to verify solutions, which provides for greater conceptual understanding and transfer (Bransford, Brown, & Cocking, 1999). Our first-grade teachers asked students to consider their peers' contributions and to respond to the mathematical content in those contributions. The examples are rather straightforward, but also hold students accountable for evaluating each other's contributions. Each of the following examples comes out of context, but each communicates to the students that they are responsible for evaluating the soundness of others' input: "Does that look correct?" "Is that right?" "Does everybody agree?" "Would that work?" "You don't think that's right? Then what goes there?" "Anybody get anything different?" "Colin, what do you think is wrong with that answer?"

These examples indicate that the first graders were solicited to lend their authority to the mathematical ideas in the classroom. These practices are in line with the National Council of Teachers of Mathematics' (NCTM's) recommendation "If students are to learn to make conjectures, experiment with various approaches to solving problems, construct mathematical arguments and respond to others' arguments, then creating an environment that fosters these kinds of activities is essential" (NCTM, 2000, p. 21). This further supports other experts' (e.g., Schoenfeld, 1986) views of how to invite learners to participate successfully in mathematics. Even in first grade, students were guided to reflect on the mathematical content—and to notice the similarities and differences of what they were thinking to what their peers were thinking. This allows young students to wrestle with the mathematics (Hiebert & Grouws, 2007), as their own work was challenged, as they were invited to challenge, or actually took the initiative to challenge someone else's work.

Public Presentation

The last teacher move that we want to highlight is a staple in mathematics classes: public presentation, or "going to the board to show the class how you solved it." We found this same pedagogical strategy in our first-grade classrooms. Even at this tender young age, teachers found successful ways for students to publicly share their solutions. This act has the effect of allowing all students to witness a particular problem-solving approach, and allows opportunities, especially in the case of inadequate or mistaken attempts, to challenge or request multiple perspectives. Even in and of itself, this strategy communicates to students that they are accountable not just for understanding the material, but also for communicating their understanding of the material, which the NCTM (2000) has endorsed.

As an example, in the first weeks of school, when ordering numbers from smallest to largest, one student had identified an error. Then, the teacher said to another student: "You come up here and help me. Tell me where to move it." In this example, the teacher asked a specific student to present her ideas publicly. Students learn that an individual's thought process is important to the whole-class discussion. This implies to all the students that they are expected to understand the material or ask questions to clarify their misunderstandings. This is another way in which teachers can show students that they control their learning and they—the whole class, teacher and students, alike—are partners in the responsibility for making sure students grasp the concepts.

How We Hope Our Research Is Taken Up Into Practice

We were delighted to contribute an article for this issue not just because Jere Brophy's work influenced the field of educational psychology and directly influenced our thinking, but also because he advocated that educational research must be meaningful to teachers. If teachers never considered research ideas and findings, then our work would lack significant impact. So it is with great enthusiasm that we write our conclusions, directed to teachers who might have opportunities to transform mere words on these pages into new opportunities for students to learn.

We start by pointing out that the behaviors we documented here are things that teachers have control over in their classrooms. There are plenty of things that teachers do not have control over (what textbooks to use, which students are in their class, and how prepared those students are on any one day, to name a few), but reminding students, for example, that everyone in the class needs to see the materials is one of the things that teachers can do every day.

Teachers are powerful socializers in first-grade students' lives. Teachers have the power to shape young minds, shape attitudes, and shape the basis for lifelong learning (Ma, 1999). If we get young students to understand that they have a role—and what their role is—in their own learning, we can set them on the path to value their own contributions and challenge and respect their classmates' and their teachers' ideas, and fully participate in learning mathematics. Teachers have the power to impact and structure the learning environment, just by what they say and how they ask questions, in ways that will serve students long past first-grade math class.

Brophy (1998; Porter & Brophy, 1988) gave us insight into this process wherein students are learning more than mathematical facts, procedures, and concepts. According to Porter and Brophy (1988), one of the habits of effective teachers is to "communicate to their students what is expected of them—and why" (p. 75), which can, in turn, foster responsibility for learning among their students. We concur: Students learn more than the mathematics; they also learn "important dispositions toward mathematics as a discipline that inclines their mathematical engagement and understanding (Lampert, 1990)" (Hamm & Perry, 2002, p. 126).

At the beginning of this article, we wondered whether teachers can get their students to "love math." We readily acknowledge that getting all of our students to love math is not an easily attainable goal. However, it appears that teachers are on their way toward that goal when they engage students authentically in the process of learning mathematics, by encouraging students to develop a satisfying connection to content that will serve them well throughout their lives. As Brophy (2008) wrote:

> Teaching for appreciation requires ensuring that what is taught is worth learning, explaining the value of this content and modeling its applications, and scaffolding learning by engaging students in activities that allow them to experience its valued affordances. (p. 132)

We believe that many of the behaviors that we have documented in these first-grade classrooms accomplish what Brophy believed we should aspire to. We hope that the examples and explanations—of various ways in which teachers explicitly teach their students how to participate and collaborate, and to understand how mathematical ideas come to be known, understood, and shared within a mathematical community—serve not just as evidence that first-graders can be engaged successfully in learning, and learning to appreciate, mathematics, but also as inspiration that teachers have the power to socialize young students and provide them with the foundation for lifelong learning and appreciation of mathematics.

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