Motivating Students Who Struggle with Mathematics: An Application of Psychological Principles

by Laurie B. Hanich

Much research on children who struggle with mathematics, including students with mathematics learning disability (MLD), is focused on cognitive skills required for success on mathematics tasks, such as number sense or computational fluency (as summarized by Michèle Mazzocco, this issue). Identifying these skills is essential to targeting educational supports. Yet a variety of noncognitive factors, such as affect and motivation, also play a critical role in children's learning of mathematics (Royer & Walles, 2007). For example, some children who struggle with math demonstrate maladaptive patterns of motivational behavior, such as disengaging in mathematics instruction or demonstrating self-handicapping avoidance behaviors. While these behaviors often serve as a defense mechanism that protects one's self image (Covington, 1992), a lack of engagement during mathematics instruction can affect a child's mathematics learning. Although engagement and motivation can influence math learning for all children, fostering adaptive motivational behaviors is essential for children who experience difficulty with mathematics.

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Although few educators would argue with the need for students to be motivated, many do not fully understand the complexity of achievement motivation (Anderman & Anderman, 2010). Factors other than inherent ability influence how students approach classroom tasks, the types of strategies students use, and how students respond to academic successes or failures. Teachers can influence students' achievement motivation and have the potential to help or hinder children's mathematics learning. The intent of this article is to provide a brief introduction to the principles from the achievement motivation literature in order to assist educators with creating positive environments that facilitate learning by motivating students. Below, I first describe maladaptive motivational profiles that characterize some students who struggle with math and explore potential consequences of such behaviors. Then, I identify and describe five principles of achievement motivation that educators can apply to motivate students who struggle in math. These principles extend to all learners and cut across content areas; however, there may be particular value in their application to children who struggle with math.

Maladaptive Motivational Profiles That May Characterize Children Who Struggle with Math

Madison is a third grade student in Mrs. Burkhardt's classroom. For the last 15 minutes she has been doodling on the workbook page in front of her. Mrs. Burkhardt walks by and encourages her to try one of the story problems that she is supposed to be working on. "I can't," claims Madison, "I don't understand it." Mrs. Burkhardt goes through the problem step by step, checking Madison's understanding along the way. Together, they solve the problem correctly. "Try the next one on your own," says Mrs. Burkhardt. "I don't know how," replies Madison. "But we just did one like this," a frustrated Mrs. Burkhardt responds. "You helped me. I can't do it on my own," Madison insists. "But you knew which steps to use when we solved it together," Mrs. Burkhardt argues. "I guessed," replies Madison. Mrs. Burkhardt moves on to assist another student and Madison returns to her doodling.

There are several possible cognitive and behavioral explanations for Madison's actions, including her perception that she lacks control over her mathematics success. It is possible that her self-perception is accurate—some children are aware of real limitations that prevent their success on a given task; or hers could be a false sense of futility resulting from experiencing repeated failure. This *learned helplessness* leads to reliance on task-avoidant strategies such as disengagement. If students have low expectations for success on a task, they may be more likely to give up easily, attribute their failure to their lack of ability, and attribute their success to external factors, such as luck or ease of the task.

Recognizing task-avoidant strategies in children who struggle with math can help teachers respond appropriately to these maladaptive behaviors. However, teachers can gain additional insights into their students' problems with math if they consider both cognitive and motivational variables that affect their students' academic performance and contribute to task-avoidant behaviors. For example, children with weak executive control or poor working memory may be less capable than their peers in handling some of the task demands associated with mathematics, as described by Daniel Berch (this issue). As Dr. Berch suggests, it is possible to diminish working memory demands to enhance mathematics learning and performance of children with low working memory capacities. Still, it is important to recognize that repeated experiences of failure can interact with cognitive motivational variables, such as children's belief systems. Cognitive competence and motivation are dynamically related (Chapman, 1988; Royer & Walles, 2007), and

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children's belief systems in turn affect adaptive behaviors for mathematics learning. Ashcraft and Kirk (2001) found that children who are highly anxious about mathematics showed longer response times and less accuracy on two-column addition problems that involved borrowing than children with lower levels of math anxiety. Although it is difficult to determine whether low mathematics performance precedes high mathematics anxiety level, or vice versa, regardless of their causal relationship, it is imperative to examine motivational behaviors.

Breaking the cycle of learned helpless behaviors is difficult, but important. If young children develop this pattern of behavior early in their academic career, their beliefs often are reinforced over time and compounded by cognitive deficits associated with MLD. Teachers should help students understand the effects of their attributions, especially when they have failed at a task. For example, student failure on tasks might be related to the selection of problem-solving strategies rather than an innate ability in mathematics. This type of message is particularly important for children with MLD, because they often use immature strategies relative to their typically achieving peers (Geary, 1990; Ostad, 1997, 1998; Russell & Ginsburg, 1984).

A relevant contributing factor to learned helplessness could be the social interactions with classroom teachers who unintentionally communicate low expectations to students regarding their mathematical abilities. Teachers who believe that mathematics is difficult and that some children lack the cognitive competencies to be successful in mathematics may not fully understand the impact of such beliefs on their students' achievement-related perceptions. Beliefs held by teachers about their students' mathematical abilities may contribute to the development of a self-fulfilling prophecy. For example, Bielock, Gundeson, Ramirez, and Levine (2010) recently found that female teachers' math anxiety affected first- and second-grade girls' mathematics achievement gains. At the end of the school year, girls with highly math-anxious teachers were more likely than boys and than girls with less math-anxious teachers to endorse the stereotype that boys are good at math and girls are good at reading. Also, the mathematics achievement of these girls was significantly lower than that of boys and of girls who did not endorse this stereotype. This suggests that teacher behavior *can* and *does* play a major role in student learning.

John is a fifth-grade student in Mr. Marshall's classroom. Although John is a skilled reader, he has struggled in math throughout most of elementary school. He has a test on fractions in his math class tomorrow. He knows that he needs to study for his test, but instead he spends the entire evening playing video games with his brother. When he fails the test the next day, he blames his failure on his time spent playing video games. A similar pattern of behavior has happened several times earlier this year. Mr. Marshall has become increasingly frustrated by John's repeated lack of effort.

Like Madison, John is engaging in another form avoidance behavior, self-handicapping. Unlike learned helplessness, self-handicapping is a proactive strategy that students use to influence others' beliefs about their ability (Urdan, Ryan, Anderman, & Gheen, 2002). In these instances children's likelihood for success is usually diminished because they have engaged in behaviors that are counterproductive to the task at hand. Students who self-handicap often do so because they doubt their ability to perform adequately on academic tasks. To avoid the implication that he lacks ability in math, John blames his failure on something within his control, studying for the test. This allows him to maintain positive perceptions of his abilities, despite his concerns about his competence. It is unknown to what extent self-handicapping occurs in children with MLD.

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What can teachers do to assist students like Madison and John? In addition to their limited proficiencies in certain areas of mathematics, students who engage in unproductive motivational behaviors are likely to augment their problems in math. Explicit instruction with students who struggle with math has consistently shown positive effects on performance with word problems and computation (Gersten, Chard, Jayanthi, Baker, Morphy, & Flojo, 2009; National Mathematics Advisory Panel, 2008; Powell, Fuchs, & Fuchs, this issue). However, given the interplay of cognition and motivation, teachers can supplement explicit strategy instruction with application of the following psychological principles to foster adaptive motivational behaviors in students who struggle with math.

Principles of Achievement Motivation

1) **Promote mastery goals and minimize performance goals in the classroom.** *Achievement goal orientation* refers to the way that students approach, respond to, and engage in achievement-related activities (Ames, 1992). Researchers have identified two goal orientations: *mastery goals* and *performance goals*. Mastery goals are characterized by an emphasis on mastering content, increasing knowledge, and developing competence. Behaviors associated with mastery goals include risk taking, utilization of sophisticated problem-solving strategies, adaptive help-seeking, and perseverance. In contrast, performance goals are characterized by an emphasis on demonstrating competence and avoiding situations that have potential to reveal incompetence. Behaviors associated with performance goals include a

focus on grades and social comparison, selection of easy tasks that are likely to guarantee success, and utilization of shallow problem-solving strategies.

Students' achievement goals can be influenced by the way that teachers structure the classroom (Ames & Archer, 1988). Instructional tasks, feedback and recognition practices, and assessment materials have an impact on children's goal orientations, which in turn affect achievement-related behaviors. For example, Turner and her colleagues (Turner et al., 2002; Friedel, Cortina, Turner, & Midgley, 2007) found a relationship between children's perceived goal structures of the classroom and their use of avoidance behaviors and coping strategies. Specifically, in classrooms where a performance goal orientation was salient (e.g., high demand for correct answers, but with little explanation or support for arriving at such), students were more likely to engage in avoidance behaviors or other unproductive behaviors. In classrooms where children perceived a mastery goal orientation (e.g., emphasis on understanding procedures and concepts as a means to arrive at correct answers), children were less likely to engage in avoidance behaviors. These findings illustrate the importance of creating classrooms that minimize performance goals over mastery goals without eliminating the importance of both procedural and conceptual learning (see Julie Booth's article, this issue).

So how do teachers promote mastery goals over performance goals in the classroom? One way is to emphasize the incremental nature of developing mathematical competence. If teachers send the message that success in mathematics is the result of self-regulated strategy use and persistence on challenging tasks, rather than the result of innate ability, children are more likely to attempt problems outside of their comfort zone and to respond adaptively following a failure situation. On the other hand, classrooms that emphasize public recognition of ability, promote feedback based on ability rather than effort, and that discourage educational risk-taking for fear of making errors, are likely to reinforce task-avoidant behaviors. By creating a classroom where students can focus on the process of learning, rather than the product of performance, students are more likely to demonstrate positive motivational behaviors, such as engagement and resiliency.

2) **Minimize social comparison and rewards based on performance.** Many educators are partial to the use of rewards as a motivating strategy, and research has identified several ways that rewards can be used effectively (see Anderman & Anderman, 2010, for a review). However, when used in ways that are inconsistent with research-based guidelines, rewards have the potential to foster task-avoidant behaviors (Deci, Koestner, & Ryan, 2001). This may be particularly true for children who struggle with math or have MLD. For example, in some elementary classrooms it is a common practice for students to complete "fast facts" worksheets, where students have to retrieve as many number combinations as possible in a two-minute time period. At the end of this activity, the child with the highest score is often identified as the winner, and winners often receive a prize or have their name posted in the class as a form of recognition. Although practicing number combinations has important benefits (see Sarah Powell and her colleague's article, this issue), from a motivational perspective, there are several problems with the reward structures used in this example. First, if only one child is identified as the winner, it might create feelings of resentment among classmates. Second, it is likely that the same child (or one of a small subset of students), usually a high achiever, wins this activity multiple times. Third, the likelihood of a child with mathematics difficulties winning this activity is slim because deficits in retrieval of arithmetic combinations are a defining characteristic of these children (Hanich, Jordan, Kaplan, & Dick, 2001). Finally, when a reward is available for only a select group of children rather than the entire class, there is potential to foster avoidance behaviors among those who perceive their chances of winning as low (Deci et al., 2001). While most students are likely to make performance gains on math facts tasks over time, their gains are unlikely to elevate them to the position of "the winner."

In addition to practices that utilize rewards, those that foster social comparison can be equally as perilous for children who struggle with math. Consider that many teachers have classroom charts that identify the level of the multiplication table facts that students have mastered. While motivating to students who are at the top of the chart, students who struggle with math might find this practice embarrassing because it draws attention to their low performance. Many children would prefer to be seen as "bad" rather than "dumb," so it is not uncommon for children who struggle with math to engage in task-avoidant behaviors when social comparison is prominent.

Although automaticity with number combinations is an important skill for developing mathematical competence, the types of reward-based practices exemplified above have the potential to foster negative achievement-related behaviors. There are other ways that this essential skill can be monitored without fostering social comparison among students. Teachers can still administer "fast fact" sheets to monitor student skill level, but base recognition on individual student improvement and progress. Feedback about performance should be kept private and children encouraged to focus on self-set standards rather than normative standards. Finally, effort and persistence should be recognized and appropriately reinforced.

3) **Help students understand the effect of negative attributions.** *Attributions* are causal explanations that children make to explain their academic successes or failures (Weiner, 1986). Consider the student who has experienced repeated failures in mathematics. When probed about the causes of such failures, the child states, "I'm not good at math. No one in my family is good at math." This attribution identifies inherent ability as the underlying cause of mathematical performance. If children believe that their mathematical failures are due to lack of ability, something

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outside of their control, they could be less likely to engage in similar tasks in the future since they believe it is likely that the outcome will be the same. However, if children believe that their mathematical failures are due to limited effort or poor strategy selection, things that are within their control, the likelihood that they engage in future tasks is high if the outcome has the potential to change.

To help students replace dysfunctional attributions with facilitative ones, teachers should foster attributions that emphasize effort, strategy use, and persistence, over ability (National Mathematics Advisory Panel, 2008). All of these attributions promote an *internal locus of control*, in which children perceive themselves as active agents of their learning, rather than passive recipients of external forces (Pashler, McDaniel, Rohrer, & Bjork, 2008). Additionally, teachers need to be aware of the unintended mixed messages they send to students, which affect the types of attributions that students make about themselves. For example, a teacher might not question making references to how "smart" children are. However, this attribution is likely to focus children on *ability* as the cause for their success, rather than *effort*. While this may not seem counterproductive to children's developing self-concepts, imagine the inverse attribution in a failure situation. Being "dumb" not only has a negative impact on a student's academic self-concept, but ability attributions tend to be relatively stable across time. Thus, stable, external attributions of failure often are outside of children's control, which has consequences for future behaviors. Finally, teachers need to continually battle the erroneous idea that mathematical competence is largely a matter of inherent ability, not effort and convey this message to students in their own instructional practices.

4) **Teach students appropriate self-regulated learning strategies.** Self-regulation strategies include self-instruction, self-questioning, self-monitoring, and self-assessment. These metacognitive functions are critical for children's academic success. Research has indicated that children with MLD are less accurate at evaluating correct and incorrect solutions, and are less accurate at predicting which problems they can solve correctly, than children without MLD (Garrett, Mazzocco, & Baker, 2006). While intervention studies that use self-regulation strategy instruction to improve mathematics performance have not been conducted specifically on the MLD population, several researchers have reported positive effects in populations of students with general learning disabilities (LD). Jitendra and her colleagues (Jitendra, Griffin, McGoesy, Gardill, Bhat, & Riley, 1998; Jitendra & Hoff, 1996) reported an increase in mathematical problem solving in elementary school students with LD using schema based instruction, which teaches students to categorize word problems into different types and then implement the appropriate strategy. Similarly, Sarah Powell and her colleagues (this issue) demonstrated that promoting strategy use improved number combination skills in third graders with math difficulties, and Montague (Montague, 1992; Montague, Applegate, & Marquard, 1993) found a significant improvement in problem-solving performance among older middle school students using *Solve It!* Common features across these interventions include an emphasis on student monitored problem-solving performances by using a variety of self-regulated learning strategies, which are first modeled by the teacher and then taught to children. The goal is that children will acquire and internalize strategies and apply them independently to guide mathematical performance.

Self-regulated learning strategies are important because in addition to guiding children's performance, they also have an impact on children's self-efficacy judgments. *Self-efficacy* refers to an individual's domain specific judgments about their capability to perform a task (Bandura, 1986; Pajares, 1996). As children experience success in mathematics, their self-efficacy is likely to increase. Higher self-efficacy is likely to contribute to a host of adaptive motivational behaviors including engagement, perseverance, and appropriate strategy use (Pajares, 1996). To assist students in developing self-regulated learning strategies, teachers need to model the appropriate strategies for students in addition to developing instructional activities that promote independent and strategic learning. Once children are provided with a variety of strategies that can be utilized on specific tasks, teachers can provide specific feedback about how and when to apply strategies. Finally, teachers can provide specific feedback about the outcome of the strategy application, noting what contributed to children's success or failure on the task.

5) **Model your own value of mathematics.** Despite the fact that some teachers do not enjoy teaching mathematics or their enjoyment of teaching mathematics is not consistent (Stipek, Givvin, Salmon, & MacGyyers, 2001), it is important that teachers model their own value of mathematics. Communicating the value of learning mathematics can help students internalize their own positive beliefs about mathematics. As mentioned earlier in this article, Beilock et al. (2010) found teachers' math anxiety had consequences for girls' math achievement by influencing the girls' beliefs about who is good at math. If students think they are capable of succeeding on a task and perceive the task as having value, they are more likely to attempt it (Wigfield & Eccles, 2000). However, if children believe that they are not capable of success, or if they see little value in the task, they may avoid it.

Teachers' knowledge of mathematics may affect their own enthusiasm for the discipline, which can improve the quality of their mathematics instruction (as discussed by Dr. Murphy and her colleagues, this issue). To help students also see the value of learning mathematics, teachers are encouraged to reflect on the design and implementation of instructional activities in mathematics and to monitor their communication about the importance and relevance of mathematics. Questions for reflection include the following:

- How interesting or enjoyable is the task at hand for students to learn and for me to teach?
- How will success on this task contribute to future mathematics learning among my students?
- How do I communicate messages about the role of effort and ability in learning?
- How do I communicate my own beliefs about the importance and value of mathematics to students?

Conclusion

The principles identified above are supported by educational and psychological research within the field of achievement motivation. All of these principles can be extended to a larger student population; however, for the purposes of this article I have targeted principles that are most applicable for teaching children who struggle with math, including children with MLD. Teachers are cautioned that these principles are not infallible and there are other important variables, such as developmental differences, group and individual differences, and differences in the learning contexts that shape and influence children's motivation, as reported in this issue. Because of the unique characteristics of children with MLD (e.g., cognitive deficits, immature strategy use, poor evaluation skills, etc.), teachers will want to reflect on the application of these motivational principles, adapting as necessary to students' individual characteristics and unique classroom environments. It is my hope that research on children who struggle with math or have MLD will continue to incorporate cognitive-motivational factors into systematic investigations of mathematics achievement that will provide educators strategies and recommendations to improve classroom instruction of mathematics.

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