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## Motivation in Mathematics

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## Motivation in Mathematics

To inform my future practice as a mathematics teacher, I conducted a review of existing mathematics education research on students' motivation related to mathematics learning. My initial research questions were: "What are the constructs of student motivation as related to mathematics learning?" and "How do these constructs inform mathematical teaching practice?" Based on my readings, I found that motivation can be understood in terms of self-efficacy, cognitive engagement, skill development, achievement motivation, self-regulation, and mindset about mathematics. Students' unproductive beliefs can undermine their progress in mathematics learning. As we shall see, motivation is related both to the goals that students set and their beliefs about how and whether they can meet those goals.

We can see the importance of beliefs toward motivation to learn mathematics by examining a common statement: "I'm not a math person." This phrase is used by a lot of people to express their distaste for mathematics. Such people believe this is a statement of fact, but it is also a statement of belief. This common phrase assumes a separation between the "math people" and the "non-math people." This assumes that people are either born with or without the ability to learn mathematics. Implicitly, this suggests that mathematics learning is not a product of hard work, but of innate ability (being a "math person"). This is what Dweck (2000) calls having a *fixed mindset* about mathematics. Since this is such a common statement and view in our culture, we support people in this belief about mathematics learning and it allows people to excuse themselves from the hard work it often takes to learn mathematics. This clearly relates to students' motivation to learn mathematics. In the following sections, I outline the key constructs of motivation identified in the literature.

## *Self-efficacy*

One may naturally expect that motivation is related to mathematics learning outcomes. One can see this in light of one of the main concepts of motivation: *self-efficacy*. Schunk (1991) explained: “There is evidence that self-efficacy predicts certain diverse outcomes [of] academic achievement” (p. 1). He later added, “Rewards are informative and motivating. As students work at tasks, they learn which actions lead to success and which to failure. Such information guides actions” (p. 8). Schunk (1991) explained that self-efficacy “affects an individual's choice of activities, effort, and persistence (p. 1).” People who have a low sense of self-efficacy for accomplishing a task may avoid it, while those who believe they are capable may readily participate. Schunk’s (1991) claim summarizes his meta-analysis of other empirical studies of the relationship between self-efficacy and learning.

Bong and Clark (1999) explained their general notion of self-efficacy in the following way: “One's perception of self-efficacy refers to the person's conviction about his or her capacity to actualize a desired outcome. (pg 149)” They also defined self-efficacy as “the conviction that one can successfully execute the behavior required to produce the outcomes” (p. 141). This classification of self-efficacy is compatible with Schunk’s definition. Bong and Clark compared self-concept to self-efficacy. For this paper I will define self-efficacy as the belief in one’s capabilities and the degree of confidence that people have in their ability to succeed at a task that matters to them. This is related to mathematics learning, because math is a task at which student want to succeed. With these task students influence their confidence with their continued progress in math. However, if they do not succeed their confidence is in influence in a negative way.

The concept of self-efficacy also applies to mathematics teachers. Schunk (1991) defined teaching-efficacy as “personal beliefs about capabilities to help students learn” (p. 12). Teachers whose self-efficacy is low might avoid helping students that are having difficulties, expend less effort to find materials, and will not reteach content in ways students might understand better. Teachers whose self-efficacy is higher might develop challenging activities, expend greater effort to help students succeed, and adapt their instruction to help students who are having trouble learning. The teacher’s self-efficacy thus relates to their motivation to enhanced student learning. Teachers' efficacy becomes substantial when they convey to students that they can help them learn.

### *Cognitive Engagement*

Another key concept of motivation I identified in the literature is *cognitive engagement*. Blumenfeld, Kempler, and Krajcik (2006) noted that, “to meet the instructional challenges of motivating students and promoting cognitive engagement, teachers must be motivated and invested in improving their own knowledge and enactment skill” (p. 478). These authors cited a number of other studies to support their arguments. They defined cognitive engagement as students ability to take what they know and use it for higher order thinking. If teacher can help students engage in activities that can help them improve their cognitive engagement, then students will have a better attitude when completing math problem. If students participate in activities that challenge them while helping reinforce basic skills, then they will learn the basic skills easier. This prepares students for routine and high-stakes assessments by engaging them in meaningful and challenging tasks. These challenges are helpful to students because it provides them with richer opportunities to learn.

The literature also indicates that student's attitudes are influenced by their teacher's acknowledgement of their progresses and accomplishments. "Teachers can support students competence by pointing out progress in conceptual understanding and skill development, and by helping students view mistakes as a natural part of the learning practice" (p. 486, Blumenfeld, Kempler, & Krajcik, 2006). When talking about conceptual understanding, you are talking about knowing more than how to mimic the procedure for solving a mathematics problem. If teachers can help students build that conceptual understanding into a lesson, then essentially teachers are helping students make sense of mathematics. Students should come to view mathematics as a subject about reasoning rather than simply a subject about computation and procedures. Teachers need to practice more of building a lesson for conceptual understanding. For example, having students create their own problems and have other students solve them. This will show that students understand the lesson and build on basic knowledge. Competency in routine calculation should be supported by conceptual sense making.

### *Skill Development*

Another concept relevant to student motivation is *skill development*, which is having the ability to solve or complete a task after multiple attempts. This is closely related to the first Common Core State Standard for Mathematical Practice: "Make sense of problems and persevere in solving them" (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Students will make mistake in mathematics. As teachers we need to let students know that it is alright to make mistakes while learning. Legitimizing making multiple attempts and productive struggle will improve their motivation by giving them the confidence to try. As teachers, it is good to give student a chance to practice. Everyone heard the phrase "the more you practice the better you get." This is true for mathematics, but as I noted

above there are many who do not believe this. We need students to believe that hard work corresponds to greater success in learning mathematics. The more effort you give to solving a problem, the greater the likelihood that you will get it right. When the students succeed at challenging tasks, motivation may often improve. This argument informs mathematical teaching practice because giving students multiple attempts on a problem can improve their mathematical confidence and achievement.

### *Achievement Motivation*

Besides skill development the literature also discussed *achievement motivation*. Heckhausen (1991) defined achievement motivation as “a preference for high standards of performance or as the willingness to work hard and persistently to reach these standards” (p. 2). Heckhausen’s study examined relationships among interest, achievement motivation, and mathematical ability. He also mentioned the quality of experience when doing mathematics and mathematics achievement. The sample consisted of 108 freshmen and sophomores (41 males, 67 females) from two Chicago suburban high schools. “They completed interest ratings and achievement motivation questionnaire.” (p. 2). Heckhausen (1991). Heckhausen investigated these aspects of student affect through a questionnaire, which was administered as part of a larger questionnaire which included background variables (e.g., life-events). The students were asked to indicate, using five-point rating scales, the extent to which mathematics is their favorite subject area (“Mathematics is my favorite subject: not at all, a little, somewhat, very, extremely,” p. 4, Heckhausen, 1991). These ratings were used as indicators of interest in mathematics.

Heckhausen’s (1991) data was not appropriate to establish a causal link between interest and achievement. However, the available evidence suggested that interest is not simply an

outcome of success. Achievement motivation is the willingness to work hard to reach your goal. The idea of this concept is to work hard to see improvement. Naturally one expects that if students were to have this attitude inside their math class, then they will improve in their math class. This promotes persistence so students will continue trying and not give up in class. Achievement motivation represents an intrinsic desire to succeed that naturally would provide motivation to learn mathematics. For example, if you have a student that set a goal for themselves and work hard trying to reach it, then teachers should be satisfied that the student is working hard to reach that goal. Relating it back to math, students may have difficulty on a particular math problem, but having motivation to solve that problem is key. Students can now work hard to solve that problem and reach that goal. This will show achievement motivation and improve their motivation in math in general.

### *Self-regulation*

Motivation is hard to measure. There is not one correct way to measure motivation but Cleary and Chen (2009) measure motivation by *self-regulation*. They argue that, “Self-regulation is defined by social cognitive researchers as proactively initiated thoughts, feelings, and behaviors that are planned and cyclically adapted based on self-generated or performance feedback in order to attain personal goals” (p. 292). It is a cyclical process where the feedback from prior task performance is used to evaluate and adjust one's methods of learning to optimize academic outcomes. Having knowledge of self-regulatory strategies does not necessarily mean that one will be skilled or motivated. Also, Cleary, & Chen (2009) mention that “task interest has been defined as the extent to which an individual enjoys or is interested in performing some task within a particular domain” (p. 293). In mathematics classrooms, this often corresponds merely to studying for quizzes and tests. If students are interested in the task then they are showing then

they may be more motivated. There is a direct relationship between motivation and the action of working toward a goal. Furthermore, having some self-regulating strategies will help show whether students do or do not have motivation.

### *Mindset*

As mentioned above, Dweck (2000) provides a commonly cited notion related to student motivation to learn mathematics. While some students have *fixed mindset* others might have a *growth mindset*. The phrase “I’m not a math person” indicates that one has a fixed mindset. Dweck (2000) explains,

Some people believe that intelligence is a fixed trait. They have a certain amount of intelligence and that is all they have. Dweck call this an “entity theory” of intelligence because intelligence is portrayed as an entity that dwell within us and we can’t change. (p. 2)

The fixed mindset for students make them think that they are either good with math or bad by birth. For example, students may think that they can only understand Algebra 1 and that is as far as they can go. Not believing that hard work can result in achieving a goal indicates a fixed mindset. Having a growth mindset is believing that one can work to become good at math. If students hold a fixed mindset, they believe people either have ability and motivation for math or they do not. Sometimes students put themselves in that mindset to explain why they are successful or unsuccessful in math. Whereas, students in growth mindsets believe they can do better in math by studying and working hard.

### *Application*

To this point, I have discussed the various constructs the literature identifies as important to students’ motivation in mathematics classrooms. How though does the literature define

motivation itself, which is an abstract concept that is hard to measure? Heckhausen, H. (1991) said that “study of motivation is the study of action” (p. 1). This is the main idea of this paper. Motivation is what drives a person to do something. My interest in all the different concepts so far discussed is to support students’ motivation in learning mathematics. Self-efficacy is a degree of confidence that people have in their ability to succeed at a task that matters to them. Cognitive engagement is when students take what they know and use it for higher thinking.

As a future teacher, I find it very helpful to understand these constructs related to student motivation. They are not enough by themselves to help students with fixed and growth mindset. However, they may help us as teachers since it is our job to support mathematical learning for all students. I see some applications for how looking at the concepts of student motivation as related to mathematics learning may inform mathematical teaching practice. Students may not think math is for them or they just not a math person. Students underestimate themselves when it comes to math. Teachers must point out progress in conceptual understanding and skill development and help students view mistakes as a natural part of the learning practice. When teachers try to support students as much as they can, they can eliminate that phrase of not being a math person to most of their students. Building students motivation in math is difficult. There may not be an easy way of solving the issue but as teachers we should try to foster productive beliefs about learners and mathematics. We can do this by supporting students in each lesson, engaging in student learning, improve our practice in mathematical learning, and encouraging are students to be confident when it comes to mathematics.

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