Influences on Motivation in Mathematics and

Their Implications for the Classroom

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What motivates students in a mathematics classroom? This question may seem simple to answer, but it is actually very complex, multifaceted, and interconnected. For starters, there is not just one view of motivation. Middleton and Spanias (1999) give a general definition of motivations as “reasons individuals have for behaving in a manner in a given situation” (p.66). Behavioral theorists view motivations as incentives for doing certain behaviors. Attribution theorists believe motivation is determined by the value placed on success. Goal theorists focus on the cognitive processes for why people do what they do. Personal-construct theorists look at how individuals think using ideas of constructs (Middleton & Spanias, 1999).

At the base of it all, there are intrinsic and extrinsic motivations, which seem to be fueled by certain goal orientations. Intrinsic motivation is affected by learning goal orientation and perceived competence. Learning goal orientation is affected by self-confidence, positive emotions, and quality of experiences. Self-confidence is affected by students’ ability to accept failure and perceived mathematics competence. The quality of students’ experiences is affected by interest. Although students’ motivations are relatively stable, research has shown that teachers and classroom environment can have an effect (Middleton & Spanias, 1999; Stipek et al., 1998). Cooperative learning, real-world application problems, and “viewing wrong answers as the correct answer to a different question” (Wells & Coffey, 2005, p. 202) are all effective ways of positively influencing students’ intrinsic motivation.

**Intrinsic and Extrinsic Motivation**

Intrinsic and extrinsic motivation are two distinct motivations that tend to interact in most academic settings. Students who are extrinsically motivated learn in order to receive rewards or to avoid punishment (Middleton & Spanias, 1999). These students have a performance or ego goal orientation. They focus on looking smart compared to their peers, rather than focusing on learning and understanding (Middleton & Spanias, 1999; Stipek, Salmon, Givvin, Kazemi, Saxe, & MacGyvers, 1998). Because of this, these students look for positive feedback from their teachers, peers, and parents (Middleton & Spanias, 1999).

Students that are intrinsically motivated enjoy learning and feel that learning is important for their self-image (Middleton & Spanias, 1999). Schiefele & Csikszentmihalyi (1995) suggest that intrinsic motivation is needed for problem solving, creativity, and comprehension. Students who are intrinsically motivated exhibit learning or mastery goals. These students often spend more time working on tasks, persist when working on difficult tasks, and are more likely to take risks. Students who are intrinsically motivated generally have a deeper understanding of the subject matter.

**Learning Goal Orientation**

Students who exhibit learning (or mastery) goal orientation value improvement and knowledge (Middleton & Spanias, 1999). Students believe that success depends on increasing conceptual understanding, developing skills, collaborating with peers, and the amount of effort put forth (Middleton & Spanias, 1999; Stipek et al., 1998). According to Stipek et al. (1998), having a learning goal orientation helps students become more attentive, more willing to take risks, more likely to choose challenging tasks, persist longer on tasks, and use more effective and creative problem solving strategies. These students also have more positive emotions and higher self-confidence, which affect motivation (Stipek et al., 1998).

**Positive Emotional Experiences**

Findings suggest that positive emotions and intrinsic motivation are needed for problem solving, creativity, and comprehension. In fact, Stipek et al. (1998) found in a study they conducted, that affective climate is “the most powerful predictor of students’ motivation” (p.483). This may be due to an idea pointed out by Schiefele & Csikszentmihalyi (1995) who suggest that intrinsic motivation is only maintained when there are positive emotional experiences. Stipek et al. (1998) assert that although there is not a lot of research on how positive emotions affect motivation, but it has been shown that increasing competence should nurture positive emotions. Promoting risk taking in an affective climate was positively associated with learning orientation and positive emotions. Positive emotions were reported in classes that emphasize effort, learning, understanding, and autonomy (Stipek et al., 1998).

**Perceived competence*.*** Perceived mathematics competence is related to emotional experiences and enjoyment of mathematics (Stipek et al., 1998). In mathematics, perceived competence influences intrinsic motivation. However, this is not necessarily true for other subjects in school. Before intrinsic motivation can begin, it is “likely that students must feel comfortable with mathematics, must be challenged to achieve, and must expect to succeed” (Middleton & Spanias, 1999, p. 67).

**Interest.** Interest is strongly related to the quality of experience, as well as achievement (Schiefele & Csikszentmihalyi, 1995). Students are more engaged in tasks, when they find them enjoyable (Stipek et al., 1998). Personal construction theorists believe that intrinsic motivation is constructed from arousal, personal control, and interest. These theorists believe that students assess the arousal, or cognitive stimulation, and amount of personal control an activity offers. From there, the student decides if the activity fits within their interests (Middleton & Spanias, 1999). When students are engaged and interested, they are more persistent, use more diverse problem solving strategies, and are more creative (Stipek et al., 1998).

**Self-Confidence**

“Confident math students are willing to try problems, learn from mistakes, and help others” (Nebesniak & Heaton, 2010, p. 99). Attribution and learned helplessness theories suggest that self-confidence in mathematics is affected by the ability to accept occasional failure as well as the “belief that effort is a mediator of ability” (Middleton & Spanias, 1999, p. 70).

**Taking risks and accepting failures*.*** Students that are not confident in mathematics are less likely to take risks. Stipek et al. (1998) define taking risks by a students’ willingness to ask questions. Asking a question is often perceived as a risk by many students. Many students choose to give up on a task rather than risk showing their lack of comprehension by asking a question (Stipek et al., 1998). Work avoidance is a coping mechanism described by goal theorists, which suggests that students simply avoid doing work so that failure cannot be attributed to lack of ability, but will be attributed to lack of effort (Middleton & Spanias, 1999). Some students expect to fail completely at any attempt to do mathematics. They develop such high levels of anxiety that it hinders their ability to learn and students’ inability to learn mathematics can actually become a self-fulfilling prophecy (Morris, 1981).

**Attribution of success*.*** Self-confidence underlies important ideas such as attributions for success and failure (Stipek et al., 1998). Every student’s definition of success is determined by his individual mathematics experiences (Middleton & Spanias, 1999). “When students attribute their successes to ability, they tend to succeed; when they attribute their failures to lack of ability, they tend to fail” (Middleton & Spanias, 1999, p. 70). Researchers have found that attributing failure to lack of effort and attributing success to ability are strong predictors of future achievement. When students feel that ability can be affected by effort, they put more effort into their work, and therefore achieve more than students who think ability is fixed (Middleton & Spanias, 1999).

Behavioral theorists have found that students enjoy tasks when they feel they have a good chance of succeeding. Expected success is determined by the evaluated intrinsic or extrinsic value, which determines how much effort students will put forth. When students feel that success is unattainable, they develop what is called learned helplessness. Students develop these feelings when there is a lack of success and they attribute failure to lack of ability (Middleton & Spanias, 1999). Learned helplessness often becomes a character trait that is viewed as unchanging; however, Middleton and Spanias (1999) urge teachers to consider that evidence suggests otherwise.

**Research’s Implications for the Classroom**

 Although motivations are developed early and are relatively stable, teachers are able to influence students’ motivations. It is most important for students to be intrinsically motivated, which leads students to having a learning goal orientation. Teachers must have a strategy to assess student motivations. If a teacher can predict the motivational constructs of her students, she can better align instruction around students’ needs. To discourage extrinsic motivation, teachers must provide opportunities to build intrinsic motivation. Teachers must show students that the knowledge and skills being taught are worth knowing. Activities that are stimulating, allow student control, and match student interests help students to value and enjoy mathematics. Thus, students achieve more, persist longer, and improve their mathematics self-confidence (Middleton & Spanias, 1999).

**Fostering a Learning Goal Orientation**

From intrinsic motivation stems the important idea of learning goal orientation. To foster learning goals, Stipek et al. (1998) suggest creating a classroom environment where mistakes are accepted as natural and errors are considered a part of the learning process. Goal theorists suggest creating an inquiry based class, where success is defined as making an attempt to understand the mathematics concepts, and teachers explain the thought processes used, to move students away from an ego goal orientation. By creating this type of classroom setting, students are less inclined to accept answers from the teacher and other students without careful consideration (Middleton & Spanias, 1999). In order to foster learning goal orientations, students must be confident in their mathematics abilities and be willing to take risks in the classroom (Middleton & Spanias, 1999).

 **Improving students’ mathematics self-confidence.** To improve students’ mathematical self-confidence, teachers must teach them to accept failure and encourage a learning goal orientation. By allowing students to struggle, they become more comfortable with the possibility of getting an incorrect answer. Increasing this comfort level helps to avoid future struggles with self-confidence (Middleton & Spanias, 1999). Creating a supportive environment where students are comfortable asking questions can also help to reduce anxiety and boost self-confidence. Self-confidence can also be improved by focusing on learning and developing a conceptual understanding rather than on memorizing the steps to get an answer or doing better than others (Stipek et al., 1998; Morris, 1981). Reliance on memorized procedures often erodes self-confidence. When a student forgets a step and lacks the conceptual understanding behind the steps, they will feel that they have failed and their confidence may be broken (Morris, 1981). If the focus of education is mastery, there is an expectation that all students can succeed (Stipek et al., 1998).

***Ensuring students’ success*.** To ensure success for all students, we need to shift the focus in schools from computation speed, reproduction of teacher examples, and correctness to conceptual understanding and learning (Middleton & Spanias, 1999). Middleton and Spanias (1999) feel that learned helplessness, lack of success, and attribution of failure to lack of ability persists because schools focus on ability rather than effort. Students need to feel that success is due to ability and effort. Attribution and learned helplessness theorists suggest making students aware that their efforts are helping them achieve more on increasingly difficult problems is crucial. Teachers should help students recognize that their failures are due to lack of preparation or confusion. Shifting the attribution of failure away from ability helps students to overcome disappointments. When students see that their efforts make a difference, they begin to see effort as a reflection of their ability, which develops a students’ self-confidence (Middleton & Spanias, 1999).

**Increasing students’ willingness to take risks.** Encouraging students to take risks is an important aspect of fostering a learning goal orientation in students. In order to encourage risk taking, teachers must create a safe environment for students to ask questions. This means an environment in which effort and learning are emphasized and where students are not allowed to criticize others for the questions they ask (Stipek et al., 1998). Teachers must also help students accept making mistakes and become more comfortable with making them (Middleton & Spanias, 1999; Stipek et al., 1998). Teachers can encourage educated guessing (Morris, 1981). “Confidence in intuition leads to more self-confidence and helps the math anxious feel less ‘out of control’ when faced with a new type of mathematics (Morris, 1981, p. 414).”

When effort defines success, students feel that they can succeed, which helps to develop positive attitudes (Morris, 1981). It is important to provide more substantial feedback on inadequate answers. Taking away points is not enough. There needs to be a focus on improvement and mastery rather than on grades and competition with classmates (Stipek et al., 1998). Self-evaluation, when done properly, can enhance self-confidence by giving multiple opportunities to learn and communicate about mathematics (Stallings & Tascione, 1996). Teachers should grade in a way that emphasizes students’ improvement and growth (Gilbert & Musu, 2008). Constructive feedback is associated with positive emotions and mastery orientation (Stipek et al., 1998).

**Increasing interest in mathematics*.*** According to Schiefele & Csikszentmihalyi (1995), increasing students’ interest in mathematics may lead to better experiences in math, as well as higher achievement and understanding. Teachers can increase interest in mathematics by creating a more active and student centered learning environment (Schiefele & Csikszentmihalyi, 1995). Allowing students to participate in class creates autonomous motivation (Gilbert & Musu, 2008). When students feel they are in control of their learning they are more likely to be interested and engaged (Gilbert & Musu, 2008; Stipek et al., 1998). Engaging tasks, according to Stipek et al. (1998), are moderately difficult, vary in format, and are personally meaningful for students. Teachers should offer meaningful problem-solving situations and real-world application problems that capitalize on student interests (Karsaint & Chappell, 2001; Schiefele & Csikszentmihalyi, 1995; Stipek et al., 1998; Gilbert & Musu, 2008). Using real-world tasks also helps promote effective solution strategies and reflection on problem solving (Gilbert & Musu, 2008).

**Implementing Changes in the Classroom**

**Using Interest Inventories**

Teachers can gauge student interest by giving a personal interest inventory (Karsaint & Chappell, 2001). This allows teachers to gather information about your students’ interests, which can then be used to create interesting and applicable problem scenarios. By getting students interested, teachers can build reasoning, conduct meaningful discussions, and detect misconceptions. This helps students to feel that their opinions and input are valued, which gets students engaged(Karsaint & Chappell, 2001). According to Karsaint and Chappell (2001), teachers can only see students’ true mathematics learning potential when they know that their students are interested.

**Cooperative Learning**

As teachers, the reality is that it may not be possible for all students to feel successful at all times. For this reason, it is important that students learn healthy coping mechanisms for failure. One way to do this is having students work with groups. Morris (1981) suggests that working together in small groups is less threatening for students with mathematics anxiety. When students work in a group, students are able to attribute failure to the group rather than to themselves and are still able to achieve individual successes, thus affording more opportunities for success (Middleton & Spanias, 1999). For high degrees of success, Middleton and Spanias (1999) assert that every student must be appropriately challenged.

In order to successfully implement group work, there must be cooperative learning (Walmsley & Muniz, 2003). According to Walmsley and Muniz (2003), the requirements for cooperative learning are: positive interdependence, individual accountability, interpersonal skills, face-to-face promotive interaction, and processing. This means that students must rely on their fellow group members; be held individually accountable for their own learning; use communication skills and conflict resolution, as well as trust group members; help each other; and reflect on the team’s achievements as well as improvements the group can make (Walmsley & Muniz, 2003).

In addition to individual accountability, there must also be group rewards (Walmsley & Muniz, 2003). If there is a group incentive for achievement, students tend to motivate each other and hold each other accountable (Middleton & Spanias, 1999). It has been found that these rewards help encourage collaboration. Students are more likely to care about each other’s success and listen to each other’s opinions and input when there are group rewards (Walmsley & Muniz, 2003). Group rewards are especially effective if they are given for appropriate social interactions and skills used within the group. Middleton and Spanias (1999) warn about the negative consequences of providing extrinsic rewards, but feel that they are effective when they are linked to goals that make achievement worthwhile (Middleton & Spanias, 1999).

When cooperative learning is successfully implemented, students feel supported by their group members. Cooperative learning reinforces self-acceptance, which makes students feel they are more academically successful, which in turn boosts students’ self-esteem (Walmsley & Muniz, 2003). Cooperative learning also encourages higher academic achievement and improves social skills (Nebesniak & Heaton, 2010). Students are able to give and receive more elaborate explanations when they work in an effective group, which improves conceptual understanding (Walmsley & Muniz, 2003). Students’ anxiety about mathematics is decreased and their confidence is increased. When students work in a group they are more confident and more willing to try problems. Rather than procrastinating, students are more likely to try problems immediately. Cooperative learning gets students involved in the learning process and increases engagement. All of this positively impacts classroom climate, communication, self-esteem, and attitudes of students (Nebesniak & Heaton, 2010).

**Finding Correct Reasoning in Incorrect Answers**

Many students experience mathematics anxiety because they feel that they will fail at any attempt to do mathematics (Morris, 1981). Teachers can “improve[s] students’ confidence to tackle challenging problems and their view of themselves as mathematical problem solvers” (Wells & Coffey, 2005, p. 206) by analyzing and emphasizing the correct aspects of a student’s answer. Wrong answers may contain a significant amount of accurate reasoning. As teachers, seeing the correct reasoning that students may have used allows us to see what students already know and build upon it. However, this type of teacher reaction to a so-called incorrect answer calls for teachers to be more open to diverse thinking and to appreciate the value of diverse responses (Wells & Coffey, 2005).

By viewing wrong answers as right answers to a different question, teachers are able to focus more on the logic and reasoning used rather than how the teacher expected a problem to be solved (Wells & Coffey, 2005). When teachers do this, students seem more willing to share their reasoning. Helping students reflect on what they have done helps them to make sense of their thinking which deepens their understanding of the mathematics and thereby increases their self-confidence as problem solvers. “Repeated exposure to this type of reflection… helps students become more confident in their problem-solving ability and become more knowledgeable mathematically” (Wells & Coffey, 2005, p. 207).

**Criticisms**

In all of the studies reviewed, the greatest flaw is that there is no causality or reason why students are or are not motivated in a mathematics classroom (Middleton & Spanias, 1999; Stipek et al., 1998). There are many variables that are correlated or associated with motivation, but a cause has yet to be established. There is little, if any, consideration of extrinsic motivators that influence students. The definitions of motivation used often vary from study to study and are hard to measure. The results of the studies are difficult to interpret. Additionally, the studies use different definitions of success (Middleton & Spanias, 1999). Middleton and Spanias (1999) point out the consideration of success on an entire problem versus success on steps within the problem as just one consideration.

 Research has left us with some additional questions such as: How do students define success in mathematics? What are the negative effects of using extrinsic rewards as motivators? How does mathematics motivation develop over time? How does motivation in a non-traditional mathematics class that is focused on conceptual thinking compare to motivating students in a traditional teacher-centered class? (Middleton & Spanias, 1999)

**Conclusion**

Entering any mathematics classroom, it is easy to see that motivation is an important part of learning. However, measuring and defining motivation and factors that impact motivation is complicated and finding a cause proves to be even more difficult. Despite the flaws and questions that remain unanswered in the area of motivating students in mathematics, the studies we reviewed still provide valuable findings. There are a variety of factors that influence students’ motivations, and in addition, every individual is different. Positive emotions and quality of experience, as well as mathematics self-confidence, influence intrinsic motivation and therefore, also influence learning goal orientation. These things are interconnected in a complicated web. Attribution of successes and failures, perceived competence, willingness to take risks, autonomy, and interest all play a part in motivating students. Gauging student interest in a survey, implementing cooperative learning, and finding correct reasoning in incorrect answers are just a few ways to motivate student. Teachers should consider all of the aspects that influence motivation as they construct lessons and monitor students in the classroom.

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