Increasing Motivation by Promoting Engagement in the Mathematics Classroom

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Abstract

Motivating students in the mathematics classroom is a struggle for many educators, and as such, is a topic of many research projects. In the following paper I will explore different theories on motivating students in mathematics. Creativity, context, classroom environment, beliefs, and competence are the topics I will explore. These topics are the focus of my paper because I believe they are central to increasing students' value and choice in the classroom, which in turn increases motivation. I will explain how these ideas relate to mathematics education, and how they can influence a student's motivation and engagement in the classroom.

Increasing Motivation by Promoting Engagement

in the Mathematics Classroom

A common complaint among educators, especially mathematics educators, is the disinterest from students in the topic being learned (Turner, Warzon, & Christensen, 2011). Motivating students to do mathematics has been a longstanding goal of teachers, with very little research done by the educators themselves. Teachers are busy and do not need the added stress of conducting an experiment to see how their students are motivated to learn (Turner et al., 2011). However, this does nothing to diminish the importance of understanding how students are motivated to learn mathematics or subdued the desire for teachers to teach in a way that is more engaging and interactive. Therefore the question remains, how are students motivated to learn mathematics?

Creativity

In a talk given by Dan Meyer at the *2014 NCTM Annual Meeting and Exposition* in New Orleans, Louisiana, he stated, "Don't make games more math-like, make math class more game-like" (2014). Indeed, students enjoy a challenge where they are also inspired to be creative. Salvador Raméntol of Catalonia, Spain, also saw the need for creativity in mathematics, and decided to increase creativity by implementing games. He, along with his colleagues, introduced *Numbers Day,* a day whose purpose is "to improve motivation towards mathematics so as to get students and teachers enjoying learning and teaching mathematics" (2011, p. 25). In his report on *Numbers Day,* Raméntol suggests letting students create their own mathematical problems, which the students will want to discuss and understand further. The study reports on ways to increase participation in mathematics by linking curriculum to the mathematics ideas, and creating mathematical games for students to play. He also suggests discussing "mathematical

curiosities," noting that not all mathematics is understood or has been discovered (Raméntol, 2011, p. 27). Although students often believe mathematics is a stagnant subject, Raméntol negates this idea by introducing students to mathematical problems yet to be solved, which in turn allows for students' creativity to be met (2011). *Numbers Day* cannot be an everyday occurrence, but of it can be implemented into the everyday classroom. By introducing mathematics as a more creative and intriguing subject, students' motivation to participate should indeed increase. Turner et al. encourages creativity in the classroom, noting that acknowledging students ideas and thoughts increases engagement (2011). In addition, allowing the students to create their own problem or introduce a mathematically perplexing question to the class can be stimulating not only for the lesson, but for the students as well.

Jim Wilson 11/4/2014 3:56 PM
Comment [1]: I am not sure what he means by quenching creativity. Stimulated? His evidence?

Some students perceive mathematics as a rote set of skills that must be memorized without any context, when in reality, this is not the case. Turner et al. emphasize the need for student involvement, acknowledging students participate more in the classroom when they are encouraged to learn, not just memorize concepts (2011). In a study conducted by Verner, Massarwe, and Bshouty, the researchers found when students were given a choice in their mathematics education, they went above and beyond expectations for the assignment (2013). The participants in this study were enrolled in an "Ethnomathematically-based teacher education" course whose purpose was to link social justice issues with mathematical ideas, centering on geometric principles. On one assignment, a student -- on her own volition -- drove to a nearby national park to photograph geometric ornaments in her surroundings, finding them in tile work. She then took this photograph back to class, where she and her group worked on finding the geometric representation of the pattern. This student enjoyed making something original, and by allowing the students to have their own creative thinking in the mathematics classroom,

motivation occurred. (Verner et al., 2013). Likewise, students are encouraged to participate in class simply because they are enjoying the art of discovery. Middleton and Jansen agree that allowing students to discover their own context for a mathematics problem can certainly enhance motivation, and they emphasize the importance of this idea in their book *Motivation Matters and Interest Counts: Fostering Engagement in Mathematics* (2011). They encourage teachers to allow their students to create their own contexts for mathematical problems, but also realize doing so can be challenging. If it is not feasible to allow this to occur, Middleton and Jansen suggest allowing the students to choose between numerous different contexts with the same mathematical goals, thus still giving students the creativity to express themselves, but limiting the scope of the mathematics being learned (Middleton & Jansen, 2011). The student in the ethnomathematics-based course was motivated by discovering new ideas, much like Raméntol and Middleton and Jansen suggest (Middleton & Jansen, 2011; Raméntol, 2011; Verner et al., 2013). In addition, allowing for creativity and student discovery in the classroom reduces the tendency for mathematics lessons to become dry, and instead allows for students to express their own ideas and passions through the mathematics presented. Not only is a student's creativity being expressed through assignments like this, but they are culturally engaging as well.

Cultural Context

Ellis, Meza, & Yopp encourage the use of a cultural context as a means of increasing student engagement (2014). These researchers suggest creating word problems in a culturally significant setting (Ellis, Meza, & Yopp, 2014). A teacher can give students value in the mathematics classroom by making connections between the mathematics being learned and the students' lives, and this is exactly what Ellis, Meza, and Yopp were determined to accomplish (Celedón-Pattichis, 2008). They noticed many of the students at their school were Hispanic, and in an

effort to increase classroom participation, the word problems they created included recipes for Horchata, a traditional Mexican rice drink. Not only was this something most students in the class were familiar with, but it was also something different than the standard curriculum, and therefore let the students who were traditionally less informed about the context be the experts. By creating a context that is relevant to the community, it allows the students to have ownership in the mathematics and thus increases students' motivation (Ellis et al., 2014). Although the teacher may not be the expert in the subject, the students who are a part of the community are experts, and can therefore help with understanding the context better (Middleton & Jansen, 2011). In addition, it allows the students to see that they have something to offer their teacher, which increases motivation in the classroom. Verner et al. emphasize when a problem is culturally relevant, it not only peaks student interest in the mathematical topic, but also gives the students value (2013). When a particular culture is chosen, the students are indirectly being told the chosen culture is more important than other cultures. Therefore if the only cultural context chosen for mathematical problems is the majority culture, the minority cultures will begin to feel disengaged and underrepresented. The *National Council of Teachers of Mathematics (NCTM)* recognizes making curriculum engaging and accessible to all students is important, stating in its position statement on mathematics for language minority students, "The mathematics curriculum must include connections to the cultural heritage of students" (Celedón-Pattichis, 2008, p. 60). By acknowledging every culture, everyone is invited to participate, and a cross-curriculum mathematics course begins to form (Verner et al, 2013). Students not only learn the mathematics at hand, but they learn more about other cultures, as well as their classmates, creating a classroom environment promoting engagement.

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Comment [2]: Ah, NCTM. When you attended that annual meeting in New Orleans, how many sessions were in Spanish? NCTM gives lip service to language minority but they are a bit passive in their actions. There were requests for Spanish language presentations but NCTM leadership declined.

Real-World Contexts

There can, however, be issues with "real-life" word problems. Meyer (2014) warns against creating a mathematical problem and then trying to fit a "real-world" context to the problem. Middleton and Jansen agree with Meyer, stating:

> In such instances, setting mathematics in a context outside itself would involve just as much, if not more, learning about how the concept maps onto the mathematics as it would about the relationship we wanted to teach in the first place. (2011, p. 113)

In essence, some mathematics is so difficult to map to a real-world context that it is better to keep mathematics "as its own context." If not, teachers run the risk of having students who struggle with the problem not because the mathematics is difficult, but because the relation between the context and the mathematics is too abstract (Middleton & Jansen, 2011, p.113). Rather than creating a quadratic function and trying to use it to model a snowboarder's path down a mountain, Meyer suggests starting with a real world context and then determining the mathematics needed to solve the task. For instance, watching a film of a 5 gallon bucket being filled with water from a hose is significantly more intriguing for students than reading a similar problem from a textbook (Meyer, 2014). By giving the students just the footage of the bucket being filled, students can ask their own questions, such as "When will it be full?" and "How can we know how fast the bucket is being filled?" Although these questions are similar to questions in a mathematics textbook, students are more engaged because they have created their own questions. In his talk at the *Annual Meeting,* Meyer points out that filing taxes is not a real-world context for middle school students, so one must be careful to make sure the context of the problem is applicable and engaging for all students (2014; Ellis et al., 2014; Verner et al., 2013). In addition, Middleton and Janson warn, "Sometimes contexts can interfere with understanding

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Comment [3]: This is unlikely if the students are creating the problem.

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Comment [4]: Depending on what information is given, this might be a question that is modeled by calculus rather than algebra.

and lead to disengagement!" (2011, p. 107). Therefore, motivating students to participate in mathematics ultimately depends on the context of the "real-world context."

Jim Wilson 11/4/2014 4:27 PM

Comment [5]: Somehow this leaves me feeling unguided by the discussion. There is so much clamor for "real world" problem but these folks seem to much more cautious.

I think a point that is missed here is that the teacher has to have a much deeper understanding of the mathematics in order to use these student generated questions. If the teacher does not handle the student questions well, the motivational value is lost.

Although Middleton and Jansen agree a context can indeed motivate students to work harder, they emphasize it must be implemented after considerable planning and preparing. "Contexts can promote personal investment in mathematics only if they are personally relevant and meaningful for students" (Middleton & Jansen, 2011, p.108). In their book, they give an example of a teacher who wanted to explain the importance of decimal places using the analogy of tipping at a restaurant. The students in her class were middle school students, however, and subsequently unaware of the tipping process, much like Meyer warns (2014; Middleton & Jansen, 2011). They had questions about the necessity of tipping and the "fairness" of the process, which were valid in the context. Instead of focusing on the mathematics for the beginning of the lesson, the teacher had to focus on the context (Middleton & Jansen, 2011). Although this can be good, as it engages students, it can also be detrimental, since it is still a mathematics classroom. Planning for a discussion of the context in a real-world problem is necessary for successful implementation of the mathematics task. In addition, a discussion of the context allows for the classroom to become more equalized – thus motivating students -- as everyone strives to know the same amount on the same topic (Middleton & Jansen, 2011). There is a fine line that must be balanced between creating a real-world context problem with an engaging context, and creating a real-world problem with engaging mathematics and context.

Classroom Environment

In an article written by Moyer and Husman (2006), the researchers note sometimes teachers are more worried about students cooperating than actually learning mathematics. Indeed, it is quite easy to be so engrossed in the classroom management side of teaching that one forgets what he

or she is actually teaching and instead focuses on making sure every student has the problems written down and is "on task." In the case study done by Turner et al., the researchers noted one particular teacher, Helen, seemed to be so focused on the administrative side of teaching she forgot to explain the topic for the day. "Although Helen's original intent involved asking students to create original mathematical questions, this goal quickly dissolved… she downgraded the task twice… It appeared that Helen was most concerned with gaining the cooperation of her eighth graders" (Turner et. al, 2011, p. 752). As a mathematics teacher, it is imperative the goal of the lesson always remains on the forefront of one's mind and does not get overshadowed by distractors that will certainly occur. Beswick also comments on this issue, stating "it is widely acknowledged that what teachers believe influences their teaching" (2006, p. 17). If teachers believe cooperation to be the most important aspect of the mathematics classroom, then the students will believe the same. After viewing the tape of her lesson quickly diminishing into mathematics that was much less engaging and much less cognitively demanding, Helen comments, "'It was just like… did I really do or say that? I don't know, and I, I try not to…'" (Turner et al., 2011, p. 752). Some mathematics teachers do not understand the importance reflecting on their teaching practices, as this can relate to students' motivation in the class, and Helen is a perfect example. Even when she was given the opportunity to reflect on her lesson, she did not really have any answers to why she did the things she did (Turner et al., 2011). Beswick even suggests specifically asking the students what the teacher believes to be important, thus giving the teacher a better understanding of the perceived classroom environment (2006). Students are incredibly insightful, and if teachers were to treat them this way more often, not only would the students be more engaged, but also feel more valued and understood in the classroom. Ultimately, the classroom environment and the teacher's beliefs about what should be

important can greatly affect the students' learning and understanding, and reflecting on teaching practices can be a great way for a teacher to improve on his or her classroom expectations.

Beliefs

Each year, students begin mathematics with a largely different set of beliefs about the subject. Turner et al. emphasize many students do not understand it is beneficial to work and struggle on a mathematics problem (2011). Oftentimes, students do not "think about thinking about math" (Turner et al. 2011, p. 734). Some students may think if a problem takes more than a designated length of time, then they are not capable of completing it and it is not worth their effort to continue to try. This issue is why it is so important to encourage students to continue working on a problem, even when it seems that the end -- or the answer -- is nowhere in sight. Beswick states, "It is not enough to get students to recite facts or perform procedures if they are not meaningful to them – i.e. if they do not really believe the procedures or their results" (2006. p.21). Taking ownership of the mathematics is very motivating for students, but having students memorize something is neither cognitively demanding nor engaging (Smith & Stein, 2011).

A way to build motivation in the mathematics classroom is by allowing students to have more influence over the classroom as a whole (Turner et al., 2011). Taking students preferences into consideration can show the students they have a shared ownership of the classroom material and can thereby increase motivation in the classroom (Raméntol, 2011; Turner et al., 2011). A teacher who can facilitate a whole class discussion is a more confident teacher, and a more confident teacher in turn creates more confident students. However, the classroom cannot just be handed to the students, as we saw previously in the case of Helen's situation (Turner et al., 2011). Smith and Stein say it best in their book *5 Practices for Orchestrating Productive Mathematics Discussions,* "By asking for volunteers to present, teachers relinquish control over

Jim Wilson 11/4/2014 4:36 PM
Comment [6]: I agree but what is the evidence. How do mathematics teachers develop this skill?

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Comment [7]: Really? Generally student beliefs are developed by schooling and very slow to change. Our students begin each year with the baggage of beliefs from previous experience in mathematics.

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Comment [8]: Somehow "continue to work hard on a problem" does not see very motivating. Getting them to internalize the tactics and strategies of problem exploration advocated by Polya, the heuristics advocated by Schoenfeld, or the problem-posing techniques of Brown and Walter seem more on target.

the conversation and leave themselves – and their students – at the mercy of the student whom they have placed at center stage" (2011). This means to successfully increase motivation in the classroom, teachers must be exceptionally prepared to teach and facilitate discussion. Smith and Stein suggest using a principle they call "selecting," which is the process of picking "particular students to present their mathematical work during the whole-class discussion" (2011, p. 8). An effective selection process can in turn lead to a productive mathematical discussion, which leads to increased student engagement and an increase in learning (Middleton & Jansen, 2011). Turner et al. suggest letting students discuss the mathematics because the students can explain the problem differently. They emphasize the inclusion of students should be a classroom norm, not something happening once a month (2011). By creating this as a classroom norm, students will participate more in class and thus become more motivated to learn.

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Comment [9]: Yes, but an ineffective selection process sends the wrong message. There were several studies a few years ago where teachers' question showed a bias. If the question was "to explain" the teach tended to as a boy; if it was to give an answer, they would ask a girl . . .

Jim Wilson 11/4/2014 4:56 PM
Comment [10]: Yes, they "can" but often the students do not discuss well and the teacher has to be adept at managing these poor responses without attaching the student egos.

Jim Wilson 11/4/2014 4:58 PM
Comment [11]: We know very little on how to help mathematics teachers develop this classroom norm.

It is also exceptionally important to emphasize whole class discussion as a classroom norm because some students are, by nature, less inclined to participate. The student could feel that sharing could cause trouble, or they do not want to start a discussion on a new topic (Verner et al., 2013). Although we cannot change students, we can motivate students by emphasizing all opinions are valid and helpful to the mathematical discussion. Verner et al. also note some students, if they feel the teacher does not care, will not share their thoughts, thus creating an unmotivated attitude (2013). This continues to support the idea that teachers' beliefs can play an important part in facilitating classroom discussion and motivation (Beswick, 2006).

However, a problem can occur when students act engaged and in reality, are not. For instance, if a teacher has made it clear the classroom will be one of participation from every student, the teacher must then be on guard for students who are merely acting like they are engaged (Verner et al., 2013). An easy way to combat this issue is to create meaningful lessons,

much like the cultural context lessons explained earlier in this paper. Teachers acknowledge mathematics can be presented in a less-than-exciting manner, and therefore students are unmotivated to stay involved in the lesson (Turner et al., 2011). Mathematics teachers who can create meaningful, engaging lessons for students are certainly more likely to have truly motivated students.

Competence

Turner et al. identify level of competence as a successful motivational strategy in the mathematics classroom. The researchers explain increasing the competence of a student works because "when students feel that they are improving, they are more likely to (a) try harder, (b) value the subject, and (c) feel proud about academic accomplishments" (2011, p. 728). Jones notes these factors as well and encourages teachers to talk or write notes to their students explaining their mathematical gains. In addition, he stresses the importance of students recognizing their own understanding, and suggests the students keep a notebook of their mathematics work and specifically reflect on their mathematical gains as the year progresses (Jones, 2008). Having students look at their own work and see their own improvement can reveal to them how they are learning mathematics, and thus increase motivation. In addition, reflecting on their work allows the students to feel proud of their new understanding of mathematics, a primary way to increase student's level of competence (Turner et al., 2011). Jones even suggests allowing students to grade some of their own assignments, which shows the students what concepts they understood, as well as which concepts are still a work in progress (2008). Including other subjects such as writing in mathematics classes can show students the diversity existing in mathematics, and thus increasing motivation to participate.

Additionally, teachers can increase students' level of competence by giving the students mathematically challenging tasks (Turner et al., 2011). Although a student may be able to complete a task with incredible accuracy, it is only successful in boosting that person's confidence in his mathematical abilities if the task is cognitively demanding. Smith and Stein define the different levels of difficulty of mathematical tasks as "Memorization, Procedures without Connections, Procedures with Connections, and Doing Mathematics" (2011, p. 16). It is important that the level of difficulty of a task is appropriate for the students being asked to work on the task, as there is a very thin line between too easy and too hard. This gives the students ownership of their mathematics learning, thus creating a motivated student.

Future Thoughts

Motivating students to understand the importance of participating in mathematics classes will always be difficult. Motivating students to want to learn mathematics will be a struggle for every mathematics teacher. Even still, there are ideas and suggestions for ways to increase student motivation, and this paper is a reflection of those ideas. Giving students a creative outlet in mathematics that is culturally or contextually relevant to their lives can indeed increase a student's desire to engage in the task at hand. In addition, teacher beliefs and how they are conveyed in the classroom has a large impact on students' motivation. Finally, a student's own view of his or her ability in mathematics can heavily hinder or advance his or her knowledge. Ultimately, there are many factors influencing a students' desire to learn and engage in the subject at hand; but by identifying just a few, future educators can learn to focus on key ideas, fostering engagement and understanding in their classrooms.

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