Designing for and Assessing Students’ Motivation in Mathematics Classes

Brooke Mullins*, Brett D. Jones, Tiffany J. LaCroix

Abstract

It can be difficult for teachers to develop a coherent plan to motivate students. This article describes a research-based model and associated inventory that teachers can use to assess students’ motivation and select engaging strategies. Classroom examples are provided along with practical motivational strategies suggested by mathematics teachers.

Keywords: motivation, assessment, instructional strategies

Published online by Illinois Mathematics Teacher on January 23, 2020.

When students are more motivated, they are more likely to engage in learning activities, which can result in increased learning and achievement (Christenson, Reschly & Wylie, 2012; Jones, 2018). In mathematics, the importance of student motivation has been noted in the statement titled “Motivation Matters!” by the president of the National Council of Teachers of Mathematics (Gojak, 2013), the 2019 special issue of Mathematics Teacher titled “Motivating Mathematics: Why Do You Do What You Do?”, and other mathematics education and research journal articles (see, e.g., Deitte & Howe, 2003; Galluzzo, McGivney-Burelle & Wagstrom, 2016; Hand, Kirtley & Matassa, 2015; Middleton & Spanias, 1999; Russo, 2016; Stipek, Salmon, Givvin, Kazemi, Saxe & MacGyvers, 1998). Yet, when teachers try to design a coherent plan to motivate their students, it can be difficult to synthesize the research because the field of motivation contains many theoretical perspectives. It can also be difficult for teachers to know how to measure students’ motivation in order to assess their own strengths and weaknesses as a motivating teacher.

To address these issues, we explain a practical motivation model that synthesizes current motivation research and that has been used by teachers at all levels, including those that teach pre-K (Gardner & Jones, 2016), elementary school (Jones & Sigmon, 2016), middle school (Chittum & Jones, 2017), high school (Ormrod & Jones, 2018), college (Jones, 2018), and professional school (Jones, Byrnes & Jones, 2019). Although the model has been used in many different subject areas, more examples are needed about how to apply the model in mathematics classes. Our goal is to help bridge the gap between motivation theories and teachers’ motivating practices in mathematics classrooms.

We begin by providing a description of the motivation model and then explain how it can be used by teachers in a mathematics classroom. In addition, we describe an assessment tool that teachers can use to identify the strengths and weaknesses of their strategies for motivating students. Lastly, we provide ideas for increasing students’ motivation based on suggestions from a variety of mathematics teachers, as well as strategies we have used in our classes.

1. The MUSIC Model of Motivation

The MUSIC Model of Motivation (Jones, 2009, 2018) provides teachers at all grade levels with key motivation ideas to consider when developing and implementing instructional lessons and activities. The MUSIC Model provides teachers with an organizational framework that is based on many different theories of motivation (including those by Bandura, 1975; Bong & Skaalvik, 2003; Deci, 1975; Dweck, 2013; Skinner, 1953; Schunk, 1971).
How do teachers know whether they are successful at creating a class environment consistent with the MUSIC Model strategies? One way is to reflect on their teaching and think about times when students were motivated and unmotivated during class (Jones, 2018). Another way is for teachers to talk to students to find out which aspects of the class they find motivating and unmotivating. And yet another way is for teachers to survey students about their perceptions of the course. In the next section, we provide an example of how teachers can survey students to assess their motivation.

2. Using the MUSIC Model of Academic Motivation Inventory

The MUSIC Model of Academic Motivation Inventory (Jones, 2017) is available for free at www.theMUSICmodel.com. There are three different versions that have been validated for use with students in elementary school (Jones & Sigmon, 2016), in middle and high school (Parkes, Jones & Wilkins, 2017), and in college (Jones & Skaggs, 2016). The middle/high school version of the MUSIC Inventory assesses five components with a total of eighteen items that students rate from 1 to 6 (with 1 indicating “strongly disagree” and 6 being “strongly agree”). To compute the scores, teachers average students’ responses to the items associated with each component. The number of items and an example item from each component is provided in Table 1.

Although the MUSIC Inventory can be used by teachers in a variety of different ways, we explain one fairly common method here. The inventory measures students’ perceptions; therefore, it needs to be administered after students have formed perceptions of a class (or an activity within a class if teachers want to assess students’ perceptions of an activity). For example, students can complete the inventory within the first few weeks of the start of school and teachers can use the results to identify and implement motivating strategies. Then the inventory can be administered again later in the school year, and the scores can be compared to
Designing for and Assessing Students’ Motivation in Mathematics Classes

Table 1: Sample items from the middle/high school version of the MUSIC Inventory (Jones, 2017)

<table>
<thead>
<tr>
<th>Component</th>
<th>Number of items</th>
<th>Example item</th>
</tr>
</thead>
<tbody>
<tr>
<td>eMpowerment</td>
<td>4</td>
<td>I have the freedom to complete my math class work in my own way.</td>
</tr>
<tr>
<td>Usefulness</td>
<td>3</td>
<td>I find math class work to be relevant to my future.</td>
</tr>
<tr>
<td>Success</td>
<td>4</td>
<td>During math class, I feel that I can be successful on the class work.</td>
</tr>
<tr>
<td>Interest</td>
<td>3</td>
<td>The math class work is interesting to me.</td>
</tr>
<tr>
<td>Caring</td>
<td>4</td>
<td>My math teacher cares about how well I do in math class.</td>
</tr>
</tbody>
</table>

determine whether or not there were any changes in students’ perceptions of the class.

As an example of how to use the MUSIC Model and how the results might look, we present hypothetical data from two students and actual data from an entire class. Table 2 provides examples of MUSIC Inventory scores from two hypothetical students in a class. These values were computed by averaging the items associated with each MUSIC component. To analyze the results, teachers must use their professional judgement along with any other data they have collected (e.g., observations, talking to students) to decide whether there are areas in which they want to make changes. The results in Table 2 indicate that both hypothetical students reported relatively low scores on the Interest component. Therefore, the teacher could begin by thinking about strategies to increase students’ interest. Because the MUSIC components are related (Jones & Skaggs, 2016), the teacher may also consider strategies related to the other MUSIC components to increase students’ interest.

In addition to examining individual students’ scores, teachers can examine the results of their entire class by averaging all student scores to gain an overall view of how students perceive the class. Figure 1 shows the results from nineteen students in an eighth-grade class prior to implementing the MUSIC Model (labeled “pre”) and five weeks later (labeled “post”), after intentionally implementing MUSIC Model strategies. Given that the pre-scores were mid-range on almost all of the MUSIC components, the teacher made several changes over the next five weeks. These changes included the following: to increase students’ perceptions of eMpowerment, she gave students choices within the class; to increase students’ perceptions of Usefulness, she connected the math to real-world situations that demonstrated the usefulness of math; and to increase students’ Interest, she included games and created activities that involved more discussion (which required students to compare answers and think about open-ended tasks). The results of the post-scores (see Figure 1) show a consistent pattern of an increase in about one-half point in all of the MUSIC Model components, suggesting that her changes had a positive effect on students’ MUSIC perceptions. Although there is no one correct solution to creating a perfectly designed motivating environment, the MUSIC Inventory allowed the teacher to make data-driven decisions and document her success at increasing students’ class perceptions.

Table 2: Hypothetical MUSIC Inventory scores for two students. Note: Scores represent averages on a scale from 1 (strongly disagree) to 6 (strongly agree).

<table>
<thead>
<tr>
<th>Component</th>
<th>Student 1</th>
<th>Student 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>eMpowerment</td>
<td>3.6</td>
<td>4.6</td>
</tr>
<tr>
<td>Usefulness</td>
<td>4.4</td>
<td>4.0</td>
</tr>
<tr>
<td>Success</td>
<td>3.6</td>
<td>4.0</td>
</tr>
<tr>
<td>Interest</td>
<td>2.2</td>
<td>1.8</td>
</tr>
<tr>
<td>Caring</td>
<td>5.3</td>
<td>4.3</td>
</tr>
</tbody>
</table>
Figure 1: Average for all students in a class for each MUSIC component (M = eMpowerment, U = Usefulness, S = Success, I = Interest, and C = Caring) before (pre) and after (post) the teacher implemented changes

Figure 2: An example of a poster created by a group of teachers to show their ideas for motivating students

3. Examples of MUSIC Model Strategies

Having determined their motivational strengths and weaknesses, teachers will need to identify motivational strategies. This section draws from our work at a mathematics teachers’ conference in which we provided a space for teachers to explore the MUSIC Model and find their own strategies for increasing student motivation in their classrooms. After we explained the MUSIC Model, participants worked in small groups to think about how they could implement the MUSIC Model in their classes and to list strategies they could use to increase student motivation in their classrooms. The mathematics teachers had a variety of different backgrounds, including number of years teaching and mathematics content areas taught. Participants included pre-service and in-service teachers who taught elementary, middle, and high school, as well as college instructors. A summary of their ideas related to each MUSIC Model component is presented here (see Figure 2 for an example poster created by one group of teachers) followed by some examples of strategies we have used in our own classes.

3.1. eMpowerment

One of the many strategies teachers developed to help students feel they have some control in the classroom was to provide them choices for how they completed their work, such as the choice to work in groups or independently. Other strategies teachers listed were to offer choices of the types of assignments to be completed and of things such as: choice boards, jigsaw methods, cubing, stations, and word problems. The teachers also noted that it would be beneficial to use discovery learning activities, Google classroom, and project-based assignments. Furthermore, the teachers recommended allowing students to use multiple representations or models for their work, so students could choose the best option for themselves. Finally, they stated that students should be involved in determining the direction of learning and have some role in developing classroom rules.

One strategy we have used in secondary and college classes is to allow students to maintain ownership of their methods and solutions to problems through the use of classroom discourse. We have used Stein and Smith’s (2011) 5 Practices for Orchestrating Productive Mathematics Discussions as a guide in creating opportunities for students to engage with one another to discuss different solutions, representations, and strategies. With the 5 Practices, instead of the teacher stating the “correct” answer, students are allowed to share
their ideas and then reflect upon the diverse strategies, to determine the best or most efficient one. By incorporating this strategy, students are given a voice in the classroom, as well as a choice in which method to use.

3.2. Usefulness

Almost all groups of teachers reported that mathematics problems related to the real world would be beneficial for increasing students’ beliefs about the usefulness of the content. They felt that the mathematics problems presented in class should relate to current events, real jobs, or future contexts as a way to connect the concepts and to make cross-curricular connections. One way to do that was by using videos and newspaper articles that demonstrate real-world connections. Another strategy they suggested was allowing students to explore and explain how the concepts would be useful, instead of having the teacher tell them; this way, it would be more meaningful to students. Finally, they proposed relating the content to graduation requirements and skills possibly required for their future jobs and careers.

One strategy we have used at the college level in education methods courses is to incorporate a cross-discipline assignment. This assignment required our pre-service mathematics teachers to collaborate with pre-service science teachers to develop an integrated STEM lesson for middle or high school students. The lesson was co-planned, tested, and presented over the course of four class periods of three hours each. The lesson was centered on investigating an engineering problem of the group’s choosing and incorporated the pre-service teachers’ content areas (e.g., biology, physics, algebra, geometry), Vernier or similar technology, and a new mathematical concept. This collaborative lesson plan helped our pre-service teachers to not only see the usefulness of applying their disciplines to local or global issues, but also understand the practicality of cross-discipline collaboration.

3.3. Success

One of the first strategies teachers provided for increasing students’ perceptions of Success was to lead a conversation with students about what success meant to them. With some guidance, that conversation would lead the class to define success as progress. This would help students to develop a growth mindset and to track their own progress as they worked through the class to meet their goals. The teachers suggested using student data notebooks or interactive notebooks and aides to assist with the tracking. Another strategy the teachers suggested was promoting the idea of productive failure. They stated that students need to understand the idea of failure and how changes can be made to become successful. Along with that, they suggested that teachers could use multiple grading methods and provide students with multiple opportunities for completing work, such as setting individualized goals, grading participation, using rubric systems, providing retakes on assignments, and implementing a variety of assessments. Another strategy they felt was important was to differentiate the material to allow opportunities for early success. They also suggested using scaffolds for activities and assignments to help students work towards mastery of skills. Finally, the teachers suggested providing feedback to students to encourage them by using stickers, writing personal notes on papers, and calling on certain students to let them shine when possible.

One strategy we have used in elementary, middle, secondary, and college mathematics classes to help students feel successful in mathematics is to incorporate “number talks,” such as those developed by Parrish and Dominick (2016). Number talks begin by posing a task or question that every student has access to; there is no wrong or right answer. Students then sit quietly and think of as many possible solutions they can develop. Each time they think of a new solution, they hold a finger up. After a few minutes, the class discusses the different solutions. By using this strategy, every student has a chance to be successful by developing at least one solution to the problem.

3.4. Interest

In relation to Interest, most groups listed some of the same strategies as provided for the
Usefulness component. These included using real-world examples, project-based assignments, and personal connections to the content. Other strategies included administering interest surveys and using the results to modify the lessons to meet those needs. Another strategy the teachers proposed was to create more buy-in from students by using attention grabbers, openers, and brainteasers at the beginning of the lesson. They also suggested varying instructional techniques and methods throughout the week so students are not doing the same types of activities every day. They wrote that students should be involved in more interactive lessons that include games, activities, and movement. Another strategy they developed was to ask students to generate data for problems or in-class examples, as a way to connect it to them. Finally, the main idea that developed for the Interest component was to make the classroom more focused on the students and less about the teacher. This would help create a personalized environment that students find interesting.

One strategy we have used in middle, secondary, and college mathematics classes to help students become interested in mathematics is to use games and activities. Games and activities allow students to become more interactive in the classroom, rather than passively listening to a lecture. Some games and activities we have used include Four Corners, Relay Race, Station Mazes, and the use of whiteboards (available at [https://padlet.com/saramullins/VCTM](https://padlet.com/saramullins/VCTM)).

3.5. Caring

Teachers found it easiest to identify strategies related to the Caring component of the MUSIC Model. Some of the main ideas they identified included building relationships with students and giving students more personal attention by greeting students at the classroom door, having general (not related to content) conversations with students, addressing students’ concerns, and attending students’ sports and activities after school. They also suggested establishing the classroom as a community in which students feel valued, which centered on the idea of respect between the teacher and students, as well as between students. Another strategy the teachers suggested was to be approachable and accessible, which included providing opportunities for tutoring, circulating around the classroom during work time, and providing enrichment activities. Finally, the teachers suggested using positive feedback to show students they care not only about their learning, but also about students personally.

One strategy we have used in secondary and college classes is soliciting student feedback. At the end of a lesson, or sometimes unit, instead of using the 3–2–1 method in which students write three things they learned, two things they would like to learn more about, and one thing they still had a question about, we modified this to have students provide three things they liked, two things they did not like, and one thing they would change. This enabled students to express their feedback about the lesson, which we then used to modify our instruction. This demonstrated to students that we respected their opinions and were willing to implement their suggested changes.

4. Final Thoughts

As teachers, and in working with teachers, we have found the MUSIC Model helpful in thinking about and implementing teaching strategies that support student motivation. One reason teachers like the model is because it is comprehensive and captures the multidimensional facets of motivation, yet it is limited to five broad categories that are easy to understand and implement. Another reason teachers like the model is that it offers a simple method for assessing student motivation and helps them to identify specific strengths and areas in need of improvement. Moreover, teachers can use the results to show parents and administrators how they are making data-driven decisions based on current motivation research. More information about the MUSIC Model and how to use it in the classroom are provided at [theMUSICmodel.com](http://theMUSICmodel.com).
References


Brooke Mullins

VIRGINIA TECH
226 WAR MEMORIAL HALL (0313)
BLACKSBURG, VA 24061
E-mail: sbm3@vt.edu

Brett D. Jones

VIRGINIA TECH
226 WAR MEMORIAL HALL (0313)
BLACKSBURG, VA 24061
E-mail: brettjones@vt.edu

Tiffany J. LaCroix

VIRGINIA TECH
226 WAR MEMORIAL HALL (0313)
BLACKSBURG, VA 24061
E-mail: tlacroix@vt.edu