

Mathematics Motivation and Engagement in the Middle School Mathematics Classroom

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I want to thank all of the parents of the students that I tutor. Thank you for allowing me to work with your kid(s). It has been a blast thus far and I can't wait to see the growth that your kid(s) make as learners.

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And Julia thanks for being the best sister ever! I love you.

Introduction

“All humans want to learn from the moment we are born.”

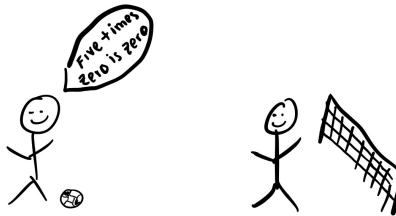
The purpose of this community engaged thesis is to improve motivation and engagement in a middle school mathematics classroom. To do this I designed five days of lesson plans for a 7th grade classroom at Lewiston Middle School. These lesson plans are based on prior experiences with math tutoring, community engagement experiences with local schools during my education minor, and extensive research that I did to create the analogy that learning is like a tree. The lessons included a mindfulness meditation, question of the day, math activity, and an exit ticket. The mathematics activities that I created include TikToks, puzzles, movement, video games, art, and a celebration of learning. Unfortunately, I was not able to teach my lessons because my research approval form was not approved. But, I have learned that we need to accept the change and grow from it. The lessons are available in Appendix B and on my math tutoring website [Mindz on the Move](#).

CHAPTER 1

My Teaching Passion

My passion for teaching started in 2015 when my high school track coach asked if I could tutor her daughter in mathematics. My whole life I had always loved math, but I had never considered teaching it. From that day forward my client base grew by word of mouth and I have seen so many kids go from hating math to loving it. Seeing a child's confidence grow as their skills improve is such a beautiful thing. I started implementing very unique teaching strategies with my students that just seemed to make sense to me. One lesson that I taught a lot with two brothers was multiplication soccer. That's all they ever wanted to do. The instructions are very simple.

Multiplication Soccer: I asked player one five multiplication questions and depending on how many they got right would determine how many shots they got to take while player two was playing goalie. We would switch back and forth for a certain amount of rounds until we had a winner. The winner was the player who scored the most goals across all the rounds.



I always try to make the math as fun as possible because most of the kids I work with either struggle with math or don't like it or both. I incorporate games like Jenga, Mancala, Connect 4 and war. I also use other outdoor activities when teaching including sidewalk chalk, croquet, Spikeball, bocce, Frisbee and more. When I meet with students online, I have had to get really creative on how to make the lessons fun and engaging since there is a screen between us. With one student, I worked on adding decimals with them by having them using Lego's. Another activity consisted of asking a student to walk around their house and graph different rooms as coordinates on the X-Y plane. A third example of an engaging activity that I did virtually was I had one of my students create an art collage of different shapes that we then found the area of. Parent permission is granted for photos.

I have always had a drive and desire to motivate kids to learn with the games I incorporate. But, what if I could take their interests a step further by showing them the value of mathematics in the world today?

1. Why is Mathematics Important?

I think back to my personal experiences with math growing up and I always loved it. Why? Because I understood it fairly quickly and easily and I love solving problems to come up with correct solutions. But now as I think about all of the other students in my school who hated math, I conjecture that a huge aspect of their disinterest is due to their experiences. In my own school experiences, no one ever talked about why we had to learn math. We just had to do it. We took many standardized tests, which may have been a reason for this disconnection. It was a part of the core curriculum and I feel like students never completely understood why. Did all the teachers even understand why?

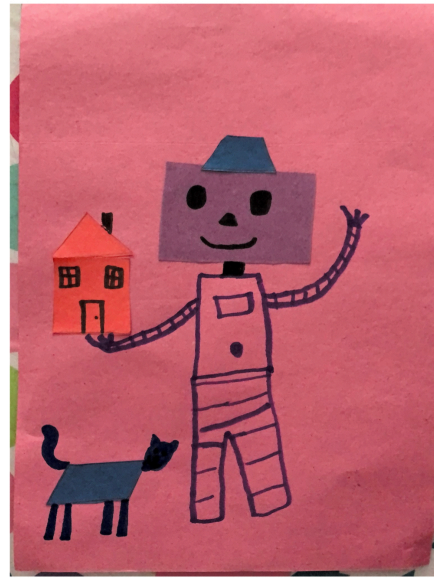


FIGURE 1.1. The image on the left is the decimal Lego activity and the image on the right is the collage area activity.

Why would a student who struggles with math want to put in time and effort to practice it if they are not told the importance of it.

Math is all around us and some of us don't even realize it. Math is a part of nature. Math is involved in telling time and reading calendars. Math was a part of creating the building that you are in now. Math is a part of technology, sports, money, cooking and driving.



I could go on and on about how math is involved in so many different aspects of our lives because it's practically everywhere. Even I sometimes forget about the many applications of math because during my tutoring sessions my students usually just have very abstract worksheets that they need help on from school and very little is related back to real life applications. My belief is that if we want students to want to learn math we need to give them a reason that it will benefit them. A purpose. This thesis aims to explore middle school students' motivation and engagement towards mathematics when the lessons are created around students' interests and use non-traditional pedagogies.

CHAPTER 2

A Literature Review You'll Actually Want to Read

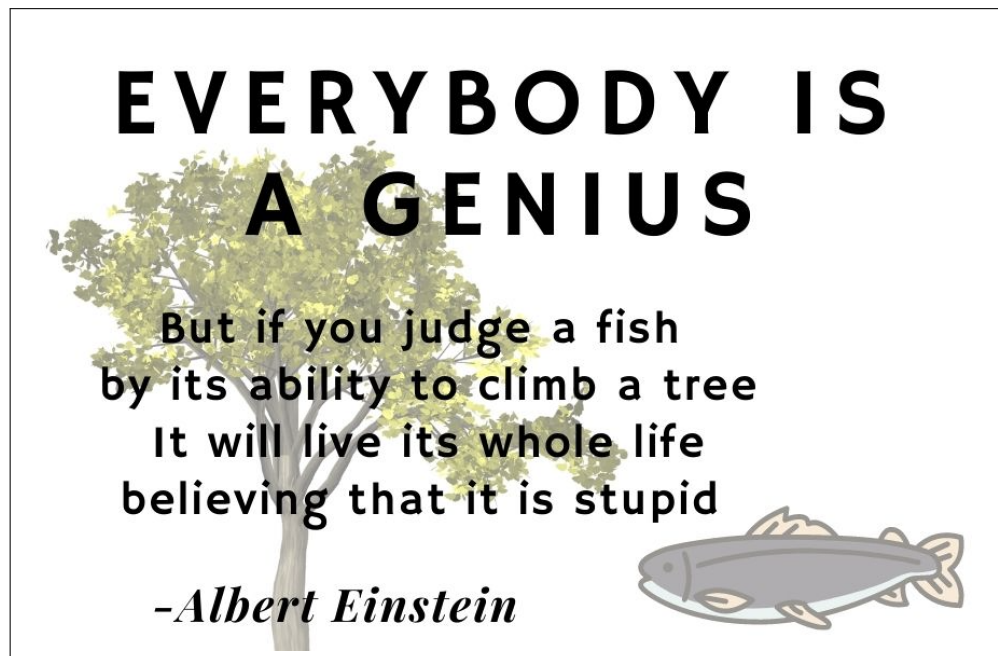
If you were to travel to a foreign country where you didn't speak the language, you could still communicate using numbers because mathematics is a universal language of the world. This may intrigue you, the reader... but if I told someone who was around the middle school age that math is the universal language, they would most likely reply with, "who cares?" As the reader of this thesis, you now know mathematics is important because it surrounds us daily, but how can you show this importance to those who don't care about the beauty and purpose of mathematics?

Activity 1. Take as much time as you need to respond to these questions.

- In general, why is mathematics important?
- Why is mathematics important to learn?
- When do you use mathematics in your daily life?
- What are some ways that you think we could motivate and engage students' curiosity in mathematics?

Now as you continue to read, I want you to refer back to your ideas and thoughts as I present my own answers to these questions from

the literature I read in response to Activity 1, which includes journal articles, books, blogs, magazines, websites, and academic theses.



1. Learning is Like a Tree

A tree has many parts to it including the roots, the trunk, the branches, and the leaves, just like learning has many components to it as well. My analogy goes like this: the roots of the tree are the students' interests, desires, and the teachers' pedagogies and creativity skills. Then the trunk of the tree includes students' thinking, engagement, and motivation. Each branch of the tree is considered to be the student learning. And going off of that when the student is blossoming they may ask for more help and consider themselves to be a math person. This idea of a math person can be applied to other subjects where a student begins to consider themselves good at a subject that they normally felt like they were bad at. To cultivate the student we need

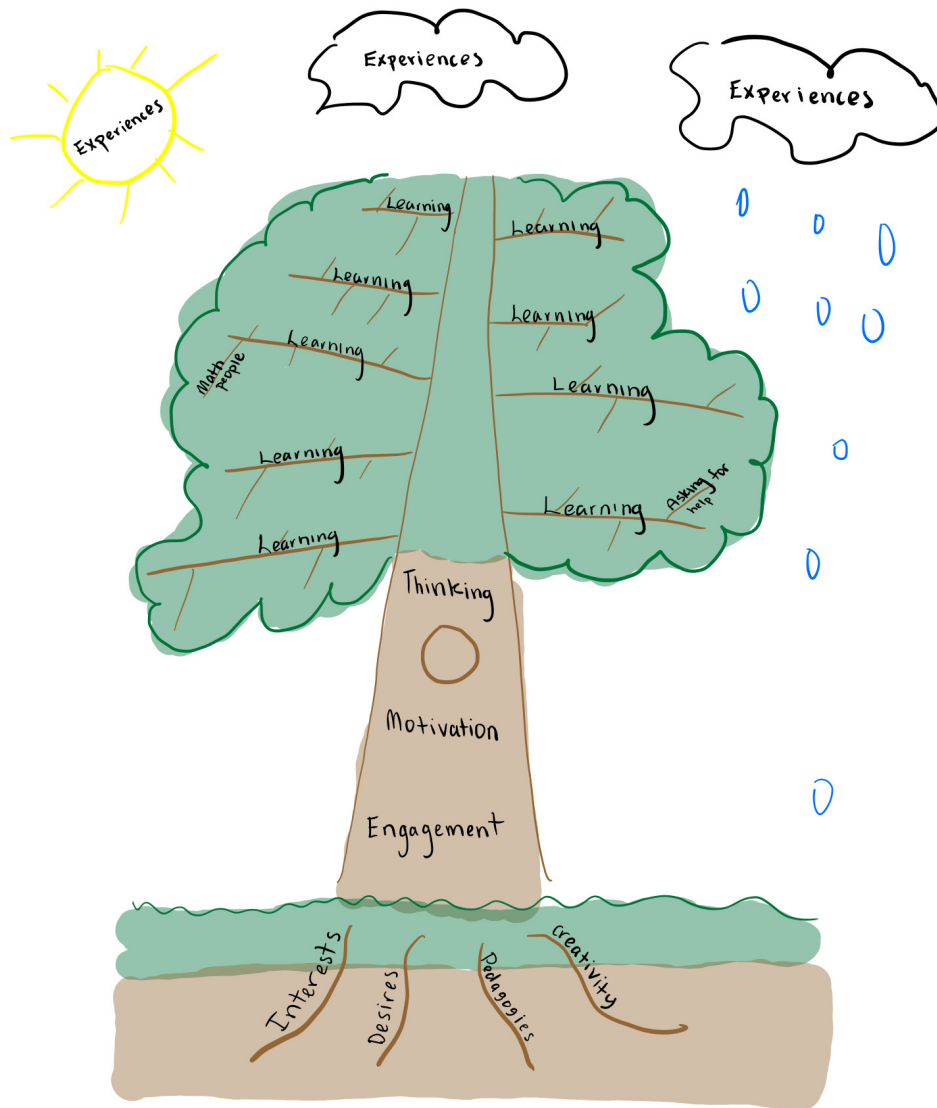


FIGURE 2.1. Learning Tree

to improve their experiences in the classroom. Students' experiences are represented by the weather that best fuels the tree including the sun, clouds, and rain.

2. How Are Experiences Related to Learning?

There is a relationship between the processes of experience and learning. Everything we experience can be deemed as a learning experience. Imagine this. You drop your Dunkin' Donuts coffee on the ground after holding it towards the lid and this makes you angry and upset. Now, you know for next time to hold the coffee tighter and closer to the bottom. In the traditional classroom students don't typically have the right kinds of experiences that are needed for learning. John Dewey remarks, "how many acquired special skills by means of automatic drill so that their power of judgment and capacity to act intelligently in new situations was limited? How many came to associate the learning process with ennui and boredom" [8]? This is especially true in math classrooms where students are given notes and problems to do as drills, which normally leads to boredom and lack of curiosity. Experience is necessary to learn, but it all depends on the quality of the experiences. As we know, a teacher's goal is to educate students and prepare them for the future. But, "preparation is a treacherous idea. In a certain sense every experience should do something to prepare a person for later experiences of a deeper and more expansive quality" [8]. Focusing on educating the student to fit their needs in the present moment will actually still prepare them for their future lives.

Teachers can't always focus on preparing students for the destination, college or a job. They need to focus on students' educational journey which will consist of all of the learning and growth the student needs to make before getting to their desired destination.

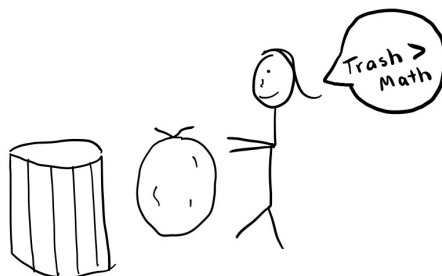
“Math class took a beautiful, imaginative, logical art, shredded it into a bowl of confetti, and assigned students the impossible, mind-numbing task of piecing the original back together” [19].

Now you may be wondering, how can we improve students’ experiences in the classroom?

Disclaimer, there are a multitude of ways to improve the experiences that students have in the classroom. I have chosen to focus and research four main ways including: students’ interests, how math satisfies our human desires, teaching pedagogies, and creativity. When we improve these four aspects of students’ education then I conjecture that they are more likely to be motivated, engaged, and curious thinkers in the classroom and in life.

3. Interests: Purpose, Value, & Personal Connection

In traditional schooling experience, many times teachers ignore the students’ personal interests and desires [8]. In 2012, “Raytheon Company commissioned an independent study to determine the learning preferences and habits of U.S. middle school students and pinpoint their perceptions and attitudes about the role math plays in the classroom and at home as well as the importance of math to their futures” [6]. One thousand students were surveyed and 44 percent of them said they would rather take out the garbage than do their math homework [2]. This shows how many students are frustrated with the subject and don’t have any interest in it [15].



That is one reason why interest is a part of the roots of the tree. We need to develop students' interests in the subject before students will more easily succeed with their learning. From elementary to middle school there are declines in mathematical interests because of the abrupt change of context and high demands of middle school [17]. "Without that interest, their mind has to work harder to find a connection to make this random piece of information make sense in their world" [16].

How can we make it easier for students to connect math concepts to their daily lives?

Activity 2. I want you to take a moment to reflect on your personal interests with mathematics.

- Why are you interested in math? Or are you not interested in it, and if so, why not?
- Are you curious about the roots of mathematics and how it impacts us daily?

To pique students' interest in mathematics we need to show them the purpose and value of math. It is also important to connect students' interests outside of mathematics to the subject because, as we know,

math is everywhere.

To simplify the subject of students' interests I will be sharing a scenario below. It is a typical conversation that I would have with my students about the importance of math before my research. Then after that there is a table that presents similar questions a student might ask and possible responses that are informed by my research.

Scenario 1

Student: What is the point in doing math?

Me: It is very important to our daily lives and you will take math classes most likely until you are a senior in high school.

Student: When do we even use math?

Me: Well, when you cook you have to use fractions, when you have to tip at a restaurant you use percentages, and you use money when you buy anything.

Student: I don't really care about those things.

Me: Okay, we have to do it though because it is your homework and if you practice math will get easier and more fun.

Student: *Sigh.* Okay.

"Those links with our everyday lives remain at its heart" 12.

Scenario 2

Student Question	Teacher Response A	Teacher Response B	Teacher Response C
What is the point in doing math?	Math helps you solve problems [21], understand patterns, define relationships, and predict the future [26].	Mat is used in all of the workforce especially with technology. "Presently technology companies are the four most valuable companies in the world " [25].	"Mathematics helps people flourish. Mathematics is for human flourishing" [25].
When do we even use math?	Technology including but not limited to, [26] [25] [21] <ul style="list-style-type: none"> • Cell phones • Computer programs • Sharing information online • Navigation • Movies 	Math is used practically everywhere including, <ul style="list-style-type: none"> • Architecture • Sports • Music • Art • Gardening • Astronomy 	Math is involved "in many different jobs by scientists, engineers, computer programmers, investment bankers, tax accountants, and traffic planners" [21].
What are some fun facts about math?	Math "has been developed for at least 4,000 years to solve problems of everyday life. In early times, mathematics was needed for trading, managing supplies, distributing properties, and even describing the motion of the stars and planets to create calendars and predict seasons for agricultural and religious activities" [21].	Math is a system of thought created by countless individuals.	Think about trying to program a robot to do those same things as a human's multifaceted brain which shows the complexity of math in our brains [12].

What is the purpose of mathematics in our present lives? “We all know there’s math under the hood, but otherwise math seems cold, logical, and lifeless. They [teachers] are giving an exercise and the definition but there is no connection to the bigger picture. No wonder we don’t feel a personal connection to it. No wonder we don’t feel a responsibility for how it’s used” [25]. “Because our system of education still concentrates on teaching the tools of life as separate subjects, we often miss the beauty of the interplay of these tools. It is only natural for students to get the mistaken impression that subjects like mathematics do not relate to anything in the real world” [22]. But we know that math can answer some of the most intriguing questions that we ask as a human race [2]. The invisible objects that mathematics is normally described as is why so many people struggle to access it [3].

A few ways we can make math more interesting are by connecting teaching to what we encounter in our daily lives [20], personalizing lessons, having parents talk about math in their lives, and teaching about mathematical history. Also we need to show students the value of mathematics because if they can’t see the purpose of math, they will eventually not like it [15]. Students who had personalized lessons based on their interests had larger increases in motivation and interests than the other students [7]. In addition, students whose math problems are personalized with context that is relatable for them actually perform better than other students whose problems are not personalized. Another way to help with students’ perceptions of math is to have parents talk more about the ways in which mathematics are in their lives [18]. Students should also study mathematical history to get a better understanding of the math culture. This will make math more relevant

to their lives which will help with getting the student more interested in the subject [21].

Since most classrooms have a large teacher to student ratio, the diversity in students' interests is a very big challenge that teachers have to deal with. This makes it difficult to satisfy every single student's interests. But, the more students' interests that are incorporated into the lessons the deeper the learning is which "would be beneficial to the quality of learning outcome" [15]. This is something that I tried to accomplish when designing my lesson plans.

4. Human Desires

One of the resources that resonated with me was a book titled *Mathematics for Human Flourishing* by Francis Su [25]. I have pulled

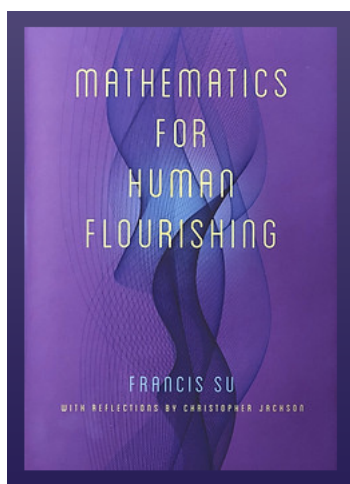


FIGURE 2.2. From the author's webpage [25].

out chapters from the book that influenced me the most and will be explaining how I used these desires to inspire my lesson plans. Desire is the second root of our tree, and thus are of the the building blocks of learning. This book emphasizes that the value of mathematics doesn't

always have to be a thing outside oneself like a utility. This counters the original idea that to improve students' learning we need to show them how math is applicable in the real world. But, if mathematics is able to satisfy all of our human desires and math is all around us, then motivating, engaging, and provoking thinking in students should be easy as pie.

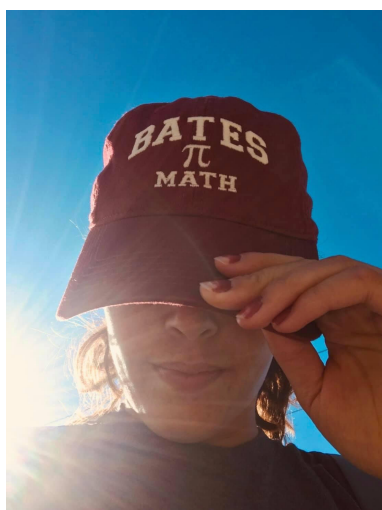


FIGURE 2.3. I got this hat when I decided to become a math major my sophomore year.

The first human desire math satisfies that I decided to focus on is exploration. “School mathematics sets you up for future exploration, but imagine how different our experiences would be if we could explore math now, as we learn it” [25]. To make this more relatable, let’s think about practicing a sport and learning all the skills, but never getting to play in the game until you are ready to be a professional athlete. That is what I experienced during most of my mathematics classes from kindergarten to college. For instance, math strategies and questions are found in many games that people play and they

don't even know it. As we know, many children ask questions of why and how during their early years of being an explorer. But, as time goes on these students stop getting curious and start memorizing the procedures. In the lessons, the students will explore how math is all around them and exists in their daily lives. They will also explore how to find probabilities from activities that they participate in during class. It is important to continue to talk about math as exploration and stop mentioning the importance of memorization. This has been challenging for me and is something I am continuing to work on. From there imagination and creativity is sparked from these explorations.

When you want to grasp the meaning of something you really are thinking about how it relates to other things in the world. Mathematics is a metaphor because you have to put the isolated concepts with other things to make them have meaning. Meaning is the second of Su's human desires that I chose to focus on. "We thirst for meaningful work, if not meaningful lives. We long to connect meaningfully with people" [25]. This is exactly why I love to teach. I love having a meaningful impact on people's lives. We need to show students the meaning of mathematics to impact the students' positivity.

Concepts in mathematics have no meaning to many of students. They are giving an exercise and the definition but there is no connection to the bigger picture. Why is this important? When would we use this math in the real world? Creating stories helps us understand how mathematics is important. During the first lesson, I will talk to the students about how math is valuable to them and one reason is, that basic math skills will be required for 80 percent of the jobs in the next decade [14].

“Memorizing times tables is boring: because they’re a heap of stones. But looking for patterns in those tables and understanding why they happen - that’s building a house” [25].

Play is doing an activity for enjoyment and also involves the imagination. This is the third of Su’s human desires that I wanted to emphasize. Some characteristics of play are that normally it is voluntary, meaningful, structured, involves freedom, exploration, and surprise. “Math play is voluntary, but driven by a deep curiosity that is nurtured through practice” [25]. This idea about math play is a driving force when designing lesson plans for a middle school classroom. I include one of Su’s mathematics puzzles into my lesson and my other lessons include activities with movement, video games, art, and food! I want students to be having fun with the activities instead of dreading going to math class.

The fourth human desire that resonated with me is beauty. “The desire for beauty is universal” [25]. The most accessible math beauty is sensory beauty and an example is patterns in nature. On day four of the lessons, I have students design a graph using their creative thinking skills. The example I created was a bar graph about how many hours a week students did homework and designed the graph like the video game, Mario Brothers (see Figure 3.4). “If mathematics is for human flourishing, then we can all benefit from grasping its beauty. But there are many notions of beauty, and many ways to motivate our study of mathematics through beauty— through art, through music, through patterns” [25].



The last of Su's human desires I want to emphasize is struggle. "The pressure from social comparison has never been greater" [25]. Students are able to find math solutions online. So why do they need to struggle? We have a desire to grow and learn as humans. One way we can learn and grow is by overcoming hardships. Teachers need to make sure students understand the value of the struggle. That struggling is actually a good thing because it means that they are learning. During my lessons, I emphasize just trying something in the classroom because it may lead to a discovery that the students wouldn't have noticed otherwise.

5. Pedagogies and Creativity

"Students do not all learn the same way, so we cannot teach them all the same way" [14].

As a teacher of almost seven years I know how rewarding it is to watch your students grow and learn over time. It is also amazing when the light bulb goes off in their brain and you can tell that they finally

understand a problem. Or, when they tell you that they liked the activity or lesson from the day. One of my tutoring students hates math and he tells me that during every single session that we have. But I decided to try something new and have him design a game with long division instead. During the session, he blurted out to me that he liked what we were doing and what a good feeling that was for me. The reason I teach is not just to explain to them the procedures and skills they need to learn. Rather, it is to build their confidence with math. That is why pedagogies and creativity are the third and four roots of the tree. Everyone is capable of learning math and liking math with some encouragement and some creative teaching styles.

During my research I have found some common misconceptions about math that include; “(a) mathematics is a set of rules, procedures, formulae, theorems, etc., (b) mathematics involves mostly calculations and equations that are either right or wrong, (c) mathematics has few applications in the real world, (d) all mathematics problems have answers and there is only one right answer, and (e) solutions to these problems usually require set procedures that students should learn from their teachers” [3]. To change this narrative, during my lessons at the middle school,

- I will emphasize how mathematics does not always have one right answer.
- I will emphasize how mathematics is not just a set of rules, procedures, and formulas.
- I will emphasize how mathematics is more than just calculations of equations to find an answer that is right or wrong.
- I will emphasize that mathematics has many applications in the real world.

- I will emphasize that not all learning comes from the teacher.

To motivate and engage students to think critically about mathematics I have collected thirteen teaching pedagogies based on research and prior experiences that are listed below. Each is listed with a #1 because all of the pedagogies are of equal importance and the order that is listed does not have any significance. This idea is inspired by a book that I read titled *Winning: The Unforgiving Race to Greatness* by Tim S. Grover [10].

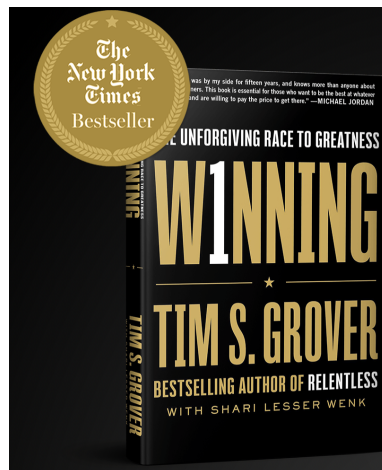


FIGURE 2.4. From the author's website. [10]

#1 Emphasize your mistakes

A pedagogy that works for teaching is your own humiliation because it shows kids that you make mistakes and are human too [19].

#1 Allow students to collaborate with each other

When students are encouraged to work together and collaborate on difficult tasks this will impact the students' involvement in a class [13].



FIGURE 2.5. Example of a personalized math problem.

#1 Allow students to choose

There has been much research that students given choice “showed more enjoyment of, better performance on, and greater persistence at a variety of activities” [7].

#1 Personalize the material

Students who have personalized lessons based on their interests have larger increases in motivation and interests than the other students [7].

#1 Allow students time to work

In schools, the message “that speed is everything” is seen especially in classes where you take tests. Success is synonymous with speed in the traditional classroom. Overall, students will learn more by taking their time and thinking slow [19].

#1 Teacher focuses on facilitating participation

Teachers should not always tell students the right way to do a problem. Instead, they should facilitate students' participation with the material and support students in making discoveries on their own [11].

#1 Show the importance of math in daily life

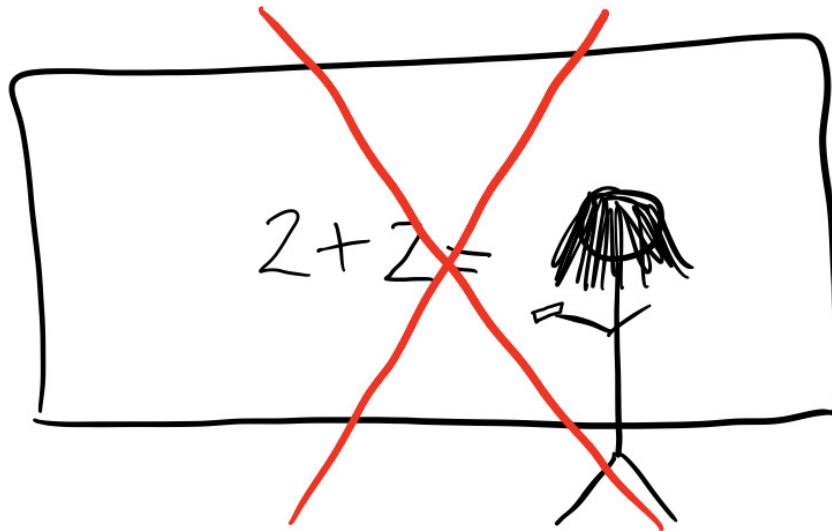
Many teachers are not aware of the importance of connecting math to the students' daily lives, which makes it difficult to implement into their classrooms [20]. Teachers need to emphasize the importance of mathematics in daily life and how math is valuable to so many high paying jobs [22].

#1 Explore of other parts of mathematics

Within the mathematics classroom teachers need to let students explore other parts of mathematics, including the history as related to human culture, patterns/designs, and games/puzzles [3].

#1 Limit chalk and talk

If all you do as a teacher is chalk and talk and never talk about the relation to the real world or play games, the students will be miserable and start to resent math.



#1 Create a welcoming atmosphere of the classroom

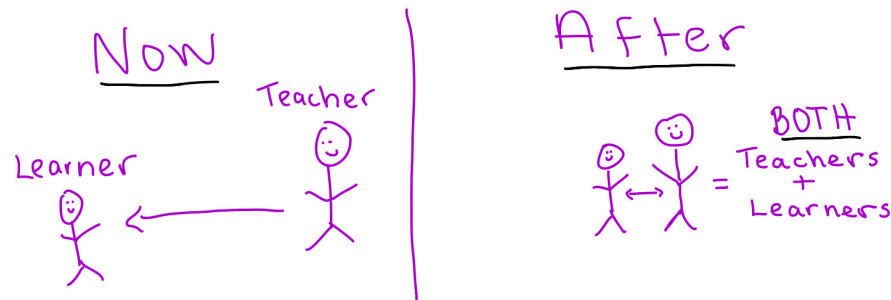
Do students feel confident to take the leap to answer questions even if they might not have the right answer? If they do, this will allow students to fully grow as learners [21].

#1 Be open to new teaching pedagogies

Teachers stated that growing up they were taught if a problem looked like this, solve it like this with no explanation as to why they use that procedure. Teachers need to have a deep understanding in mathematics in order to teach their students at a conceptual level [1].

#1 Close the power gap between students and teachers

Teachers are thought to be the enforcers of rules and people with all the knowledge given to the children. There is a large power gap between the adults and children with the current methods of learning [8].



#1 Be an advocate for changes in your curriculum

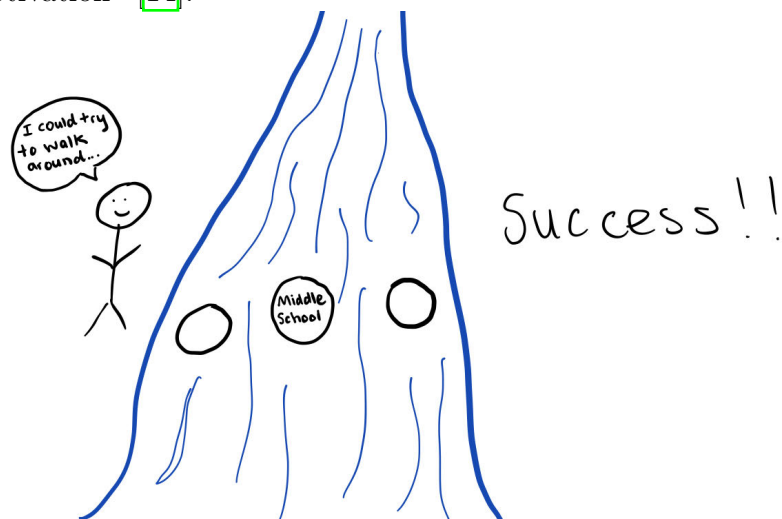
The curriculum leaves very little room for teachers to dive into topics that their students are actually curious and excited to learn about. “There isn’t enough time in their day, nor space in their classroom, to engage in various modes of communication, to accommodate multiple learning styles, and to personalize lessons to make them meaning for each student; students need to fit into the classroom environment, not the other way around” [16].

Teachers have very little prep time, let alone time to make lessons that are creative. The five day lesson plan that I made took around twenty hours to create. I hope these lessons can be easily accessed and used in many classrooms. We know that there are so many resources available for teachers now to take that leap of faith and to make their classrooms more engaging [9]. But, we need to acknowledge the school board and state legislative involvement especially in public schools.

Next steps in the learning process include motivation, engagement, and thinking

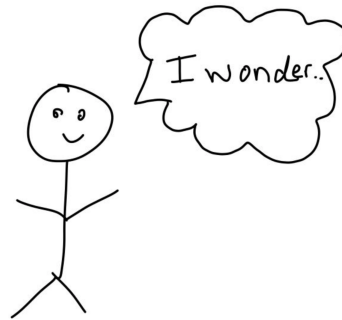
6. Motivation

Many students ask, “why do I need to learn this?” and many teachers will respond that it’s a part of the curriculum. If the students can’t see a connection to their real lives, motivation and true learning without external motivators will be a challenge. A few years after preschool, children seem to start having motivational difficulties and this increases as children get older [7]. Motivation is a part of the tree trunk because students’ motivation steadily decreases from third grade through high school. A reason for this motivational decrease is that the material is presented in its most abstract form hoping to get a generalized education for all [7]. Middle school mathematics is considered to be a crucial stepping stone for a student’s academic success, but motivation to learn math at this time period drastically drops. “This may lead to boredom and a passive attitude toward the subject resulting in reduced motivation” [14].



Motivation is defined in [16] as putting in effort to keep trying to accomplish the task even when faced with challenges. There are external and internal motivators everywhere in life. An *external motivator*

is something that motivates you and is outside of you. An *internal motivator* is motivation that comes from within yourself. In an article I read about unschooling which falls under the umbrella of homeschooling, Pam Laricchia stated the student's "motivation to learn things is intrinsic, or internal, driven by their wish to reach their own goals" [16](#).



The traditional school systems have many external motivators including awards, charts for behavior, stickers, and the biggest external motivators are grades.



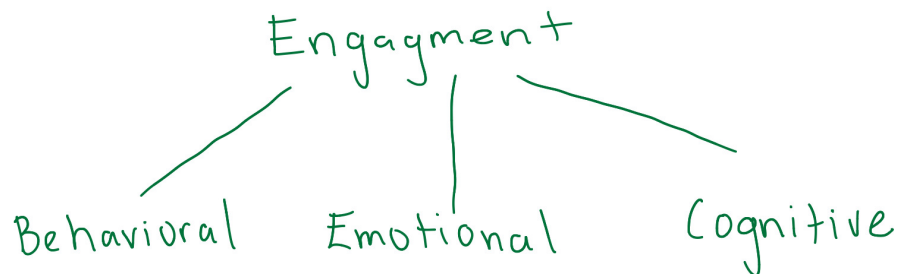
These motivators are meant to help encourage students to learn. But in the big picture students are not really motivated to learn the content but are motivated to get a good grade. The external motivators that are supposed to encourage students to learn actually diminish their motivation to learn.

Which style of motivation do you think will help students develop into lifelong learners?

As children get older we start to remove the links to everyday interest which will in turn affect their intrinsic motivation levels to learn new things. There are two major strategies for increasing students' intrinsic motivation including personalization of material and opportunities for choice. Most of the motivation can be obtained by applying fictional context that is of interest to the students to the abstract mathematics problems. This is shown in Figure 2.5. Some prior research has identified possible causes for intrinsic motivation including: pleasure from solving challenging problems, curiosity, and personal control. Students who had personalized lessons based on their interests had larger increases in motivation and interests than the other students 7. We need to get students to feel like their education has a purpose because that is when they will be motivated to learn 16.

7. Engagement

During middle school and high school there is a drastic drop in science and mathematics engagement 13. *Engagement* is defined as being curious about something that has caught your attention and when engaged you are making observations and figuring stuff out 16. In the tree analogy, engagement is a part of the tree trunk because it holds everything together in learning. Engagement is considered to have three components: behavioral, emotional, and cognitive engagement 13.

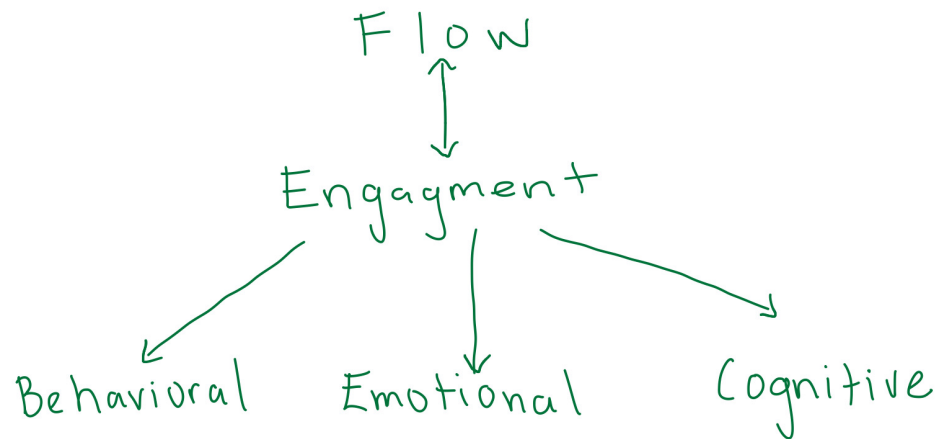


Behavioral engagement is defined to consist of attention, participation, and no disruptive behavior. During interviews in one of my readings, students and teachers mentioned behavioral engagement indicators to be on task behavior, attention, sharing ideas, asking for help, getting good grades, and body language [13]. Behavioral engagement is also defined as being compliant with the rules and procedures of the school and classrooms [15].

Emotional engagement is defined to be any reactions to peers, teachers, and a sense of belonging. Emotional indicators that teachers and students identified in the interviews are having an interest for the learning, value of the subject and individuals perception on the subject, and positive and negative emotions that included anger, confusion, tiredness, and being overwhelmed. “For example, both teachers and students discussed positive emotions, such as happiness and pride, and negative emotions such as frustration, anxiety, and anger, when describing their experience of being engaged and disengaged” [13].

Lastly, *cognitive engagement* is defined as someone’s willingness to put in effort [17]. Cognitive engagement involves thinking, learning and problem solving [15].

Being completely engaged with your work can also be defined as to be in the flow of your work.



Flow is the state of being where you are completely immersed in the activity or work that you are doing. When I am in flow I forget about the time and anything else that is going on in my life. I am completely present. “Mihaly Csikszentmihalyi is the author of *Finding Flow*, describes flow as the joy of complete engagement” [16].

Engagement is on the tree of learning because once students are behaviorally, emotionally, and cognitively engaged they are learning. Or that much closer to learning. Engagement can look different for different types of students. One student could be memorizing, one student could be interested in deep meanings of math, and yet another student could be doing it for the grade. They are all still engaged in mathematics, but in the future their level of learning and understanding will differ [15].

8. Thinking

“No one can tell another person in any definite way how he should think, any more than how he ought to breathe or to have blood circulate” [8].

The third characteristic of the tree trunk is thinking which is not just memorizing. “Real thinking is about making those learning connections that bring deeper understanding; it’s about analyzing facts and situations and letting creativity loose to see them in new ways; it’s about noticing the hidden gems of opportunity, brainstorming lots of options, making choices, and seeing how they play out” [16].

Most math teachers agree that they want to present the topics in a way that is flexible and fosters thinking. But, “students want-and-need to know the answers to their mathematics questions without the teacher telling them to think through the problem” [21]. “Due to time constraints with schooling and the curriculum, teachers may start thinking for their students, thus encouraging student passive behavior” [3]. This does not allow for enough time for students to truly think. Therefore, the student becomes “mechanical, and thus restrictive of intellectual power” [8].

Once students are motivated, engaged, and thinking, then they are truly learning.

9. Learning

What is learning when not in a traditional school setting? It is life. Learning is represented by the branches on the tree because we are

always learning new things and improving upon our knowledge. It is very important to think about how students learn, not just what they are learning. “Their internal drive to meet goals of their own choosing, learning along the way, vastly exceeds the external motivation of behavior charts and grades” [16]. Below are some photos of me learning how to do gymnastics, how to play piano, how to play soccer, and how to fish.



9.1. Math People and Asking for Help.

The last part of the tree analogy that I focus on is the small branches that come off from the learning branches. These branches can represent many different aspects of learning. I chose to focus on asking for help and considering yourself a math person.

One issue is that many students are able to determine when they need help when they become adolescents, but many do not seek help. Students normally feel threatened when asking a peer for help and would rather just not ask anyone [23]. Once students are truly learning they are more likely to ask for help in a classroom because they feel more comfortable and confident in themselves.

Many students believe that mathematics takes a special talent even though it is considered to be a subject for all because it is in most kindergarten through twelve curriculum. Also, many students have anxiety about mathematics because of the high standards of it in their household and at the school [15]. “Due to the fact that society emphasizes the value of mathematics and its place as an ‘intellectual’ discipline - only ‘smart’ people can do mathematics” [3], this can cause students to feel like math is not for them. ¹

I haven’t researched this topic extensively, but during my personal experiences with students that I have tutored once they are engaged, motivated, and thinking, they were more likely to consider themselves a math person and were more confident when asking for help.

¹This idea came from a video I watch called The Math People Myth. To sum up the video, Nate Brown explains that people think that they are either a math person or not a math person. Where in reality this topic is best represented as a bell curve, not a binary. From [4]

CHAPTER 3

Methodology

This thesis is a community engagement project which means that I created and designed lessons for the improvement of student motivation and engagement in the middle school mathematics classroom.

Community engaged research has three main components including collaboration, social change, and values multiple methods, modes, and sources of knowledge. The goal of a community engaged thesis is to contribute to the betterment of a particular community and in this case, Lewiston Middle School.



Image from Freepik.

The steps that were involved in my thesis included finding a community partner willing to collaborate, doing background research on improving learning based on my personal experiences with tutoring and working with local schools, completing the research approval process, observing the classroom, writing lesson plans, and meeting with a teacher to discuss the lesson plans.

1. Pre-Survey

I designed a [pre-survey](#) for the students to fill out before the lessons to gain an understanding of their motivation and engagement in the classroom. This survey is also intended to get an insight on what the students are most interested in which could be incorporated in future lessons. Another major aspect of the survey is to find out how much students value math. Some of the questions are open ended, some are on a one to five scale, there is a multiple choice question, and one checkbox response where they can choose as many as they desire. The survey is in Appendix B.

2. Lesson Plans

Based on prior experiences with tutoring, working with local schools during my college career, and my research, I created a five day [lesson plan](#) that aims to increase student motivation and engagement in the middle school mathematics classroom. This probability unit is designed based on the standards from [Illustrative Math](#) which is the math curriculum that Lewiston Middle School uses. The standards include 7.SP.C.5, 7.SP.C.6, 7.SP.C.7, and 7.SP.C.7.a. and can be seen in more detail below.

- 7.SP.C.5 states that students “understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around $1/2$ indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.”

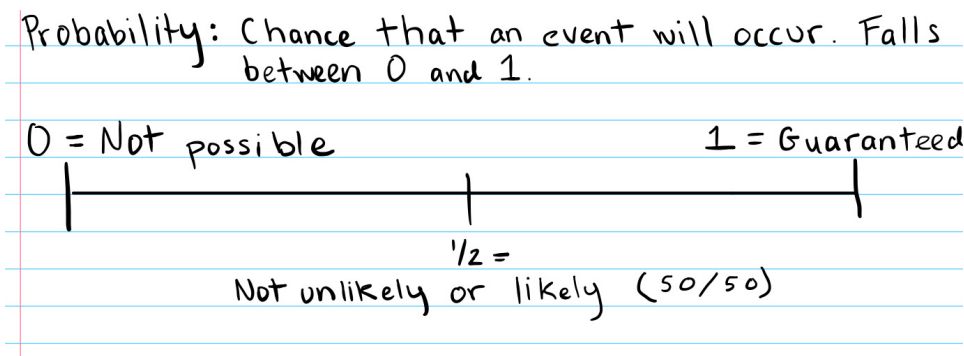


FIGURE 3.1. Part of the notes on probability from day two of the lessons

- 7.SP.C.6 states that students can “approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability. For example, when rolling a number cube 600 times, predict that a 3 or 6 would be rolled roughly 200 times, but probably not exactly 200 times.”
- 7. SP.C.7 states that students can “develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy.”
- 7.SP.C.7.a states students can “develop a uniform probability model by assigning equal probability to all outcomes, and use the model to determine probabilities of events. For example, if a student is selected at random from a class, find the probability that Jane will be selected and the probability that a girl will be selected.”

The unit has five days of lessons. The themes for each day are:

- (1) Math in the Real World and Human Desires
- (2) Movement and Probability
- (3) Video Games and Probability
- (4) Art and Graphing
- (5) Art Gallery Celebration

Each lesson is designed with the intent to increase student motivation and engagement in the math classroom. Movement/sports, video games, and art were chosen as ways to engage students based on interests outside of the mathematics classroom. I have found that these topics are of common interests with my tutoring students and prior classroom experiences. Now, I will go into some detail on the math activities for each day and proceeding that I will explain a generalized outline for all five days. All materials from section 2.1 are in Appendix B.

2.1. Synopsis of Math Activities.

Day One: Math in the Real World and Human Desires. For day one the learning target is that, “I can identify two to three places where math is in the real world.” To help the student achieve this learning target, I designed a [Google Slides presentation](#) and a [guided note sheet](#)

For the math activity portion of day one within my Google Slides presentation,

the teacher has the students watch eight TikTok videos. The purpose of this is to get the students engaged using an interest of theirs.

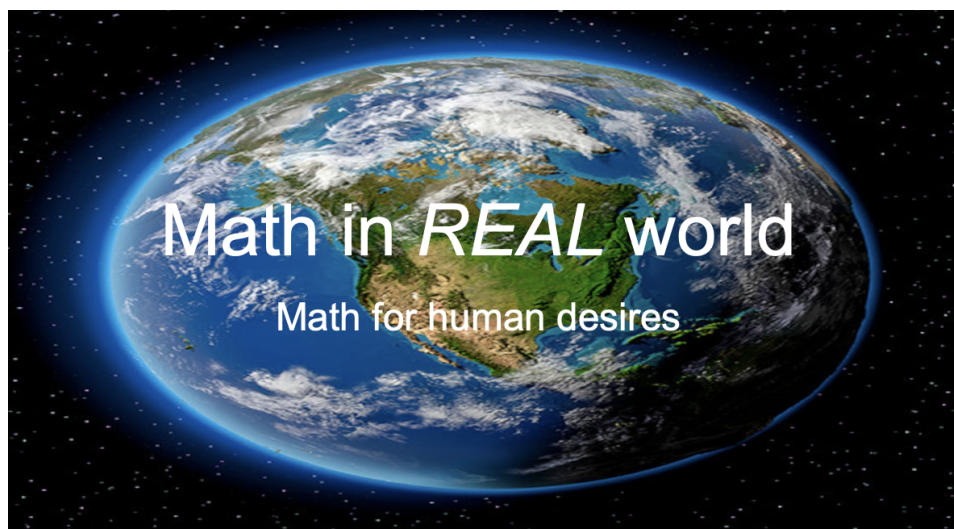


FIGURE 3.2. This image is from the first slide of the day one Google slideshow.

TikTok is a social media platform that many of the students use. During the videos, the students have two discussion questions on their [guided note](#) to respond to. Then I blocked in some time for the students to discuss their responses with their peers at their table. The second activity is having the students attempt math logic puzzles. This idea came from *Mathematics for Human Flourishing* by Francis Su [\[25\]](#), which I extensively referenced during my literature review. The students can choose which puzzle they would like to attempt and they are welcome to work together in their group. The answers will be shared at the end of the unit. The next section will be the most “Chalk & Talk” that happens during this lesson. The teacher will be talking about math in nature, math in the real world, and math for human flourishing that will last a little over five minutes. The details of this lecture can be found in the [lesson plan](#) document and is also attached



FIGURE 3.3. This is an image from one of the cards in the game *Beat that!*

in Appendix B. To close up the activity of the day, the teacher will give the students a brief schedule of the topics for the rest of the unit.

Day Two: Movement and Probability. For day two the learning target is that, “I can find probabilities from events and find how many times an event occurs when given the probability.” To begin the activity the teacher will give a short five minute explanation on what probability is and two examples of the types of problems they will encounter during the activity. The activity has five movement activities from the game *Beat That! The Bonkers Battle of Wacky Challenges*.

The students will be broken into five groups of about three students. If the class is larger than fifteen students, one could add more movement stations to keep the groups small. The students will get about seven minutes for each station to complete the movement activity and the proceeding math questions. The students are encouraged to work together and the teacher can facilitate their learning by walking around to make sure they are engaged in the activity.

Day Three: Video games and Probability. For day three the learning target is the same as day two which is that, “I can find probabilities from events and find how many times an event occurs when given the

probability.” The students will play [Google Snake](#) as a class and then answer probability questions similar to day two. The teacher will create a randomized list of the students and go down the list to ask who would like to play the game. The game will be conducted on the teacher’s computer and projected on the front board so the other students can watch and cheer on their classmates. Five students will get an opportunity to play one time with a max time limit of two minutes. After this students will work on the math based on the data from the game. After, this will be repeated. Five more students attempt the game and then the students will do the math calculations for all 10 of the scores.

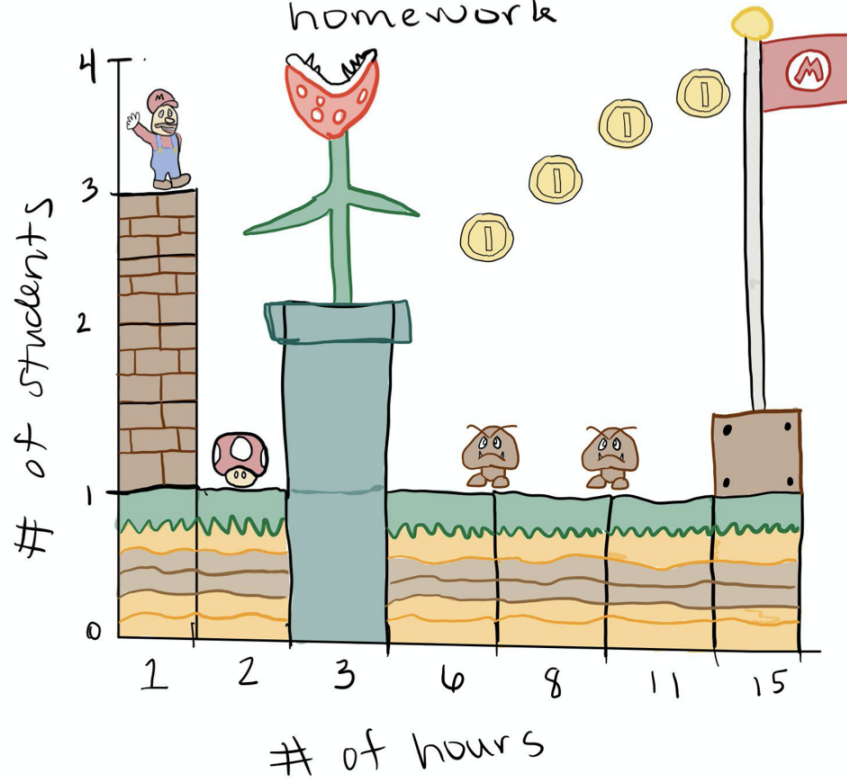
Day Four: Art and Graphing. For day four the learning target is, “I can create a bar graph with data from an event.” To start the teacher will go over common types of graphs used in a mathematics classroom and then more detail about bar graphs. Then the teacher will go over the directions for the graphing activity where the students will create graphs with the Google Snake data from day three. The fun part of this lesson is the creative aspect where students can make their graphs have extra details unrelated to the data. For example, a line graph could be designed to look like a ski slope or Mario Brothers (see Figure [3.4](#)).

An important part of this lesson is to explain to the students that these graphs will be used tomorrow during the art gallery walk.

Day Five: Art Gallery and Celebration. The learning target for day five is, “I can have meaningful conversations about my math with my peers.” The art gallery will start with the students looking at all of the art graphs and writing a question or comment on a sticky note. These sticky notes will be posted on the board up front as conversation starters for the students. I also created a guided questions and

Data: 1, 1, 1, 2, 3, 3, 6, 8, 11, 15

Hours a week students spend on homework



Miss. Berube

FIGURE 3.4. Example of a bar graph using the theme of Mario Brothers.

sentence starter sheet for the students to use during the gallery walk. These are found in the [guided note sheet](#). To begin the art walk, half of the students will be the presenters, while the other half will be observing. Each student will be having one-on-one conversations with each other for two minutes and they will rotate three times. After that the students will switch roles.

The final activity from day five was supposed to be a celebration of their learning with food and drinks. I actually received a grant from Bates College to get food and drinks for the students, but gave the money back because I didn't get to teach.

2.2. General Outline of the Lessons.

In general, the lessons follow this general outline:

- (1) Question of the day
- (2) Mindfulness meditation
- (3) Math Activity
- (4) Exit ticket

Each day of the unit starts with a 'question of the day'. This question is designed to get students thinking and comfortable with the space they are in. An example of a question I've asked before is, "would you rather have more time or more money?" The second activity is a one to two minute meditation on an app called Headspace. This idea is from a local non-profit [Rosati Leadership Academy](#) who starts their days with meditation.



This is aimed to improve students' focus and sense of awareness during the activity that proceeds¹. Then the lesson proceeds with the math activity, lasting around thirty-five minutes. Lastly, the students fill out an exit ticket to give feedback about their motivation, engagement, and any changes that they would like to see in the future.

3. Exit Tickets

The students will fill out an exit ticket after each lesson and these are found in Appendix B. All of the exit tickets ask students to rate their engagement with the lesson from one to five, to rate the lesson on how much fun that they had, and if there was anything that they would change about the lesson. Then some of the exit tickets ask a question relating to the lesson that they had. For example, on the [day one exit ticket](#) I ask students to write down two to three places math is in the real world and in their opinion if math seems valuable in the real world. Similarly, on [day three](#), I ask the students how confident they are in solving a probability problem. This is to gain insight if the students feel more comfortable with the material after covering the same math concepts for two days.

4. Post-Survey

In the [post-survey](#) which is given on day five of the unit, I added a few questions in regards to the day five lesson and a few questions about the overall unit. The post-survey is found in Appendix B. But other than that, the questions asked were the same as the pre-survey

¹What is mindfulness? “Mindfulness is a state of intentional, nonjudgmental focus on the present moment” [\[24\]](#). Also, here is a TedTalk [\[5\]](#) talking about mindfulness in schools.

because I am curious to see if the lessons had an impact and improved student motivation and engagement. The additional questions are:

- After completing this mini unit, do you see math differently?
- Any suggestions for this mini unit? (I'd love to hear your feedback.)
- Is there anything else that you want to share?

Based on my experiences with tutoring, hearing feedback from your students that is both positive and negative is super beneficial to both you, the teacher, and the student. It allows you to continue to grow as a teacher while helping your students grow as learners.

CHAPTER 4

Discussion

1. Teaching Pedagogies

In chapter two I mentioned the 13 pedagogies that I think are the most important for teaching. As I was creating the lessons I considered all of the pedagogies and tried to figure out how to fit them into the lessons. Below is a table with five teaching pedagogies and simplified descriptions on how they were implemented in the lessons that I created for this thesis.

Pedagogies	Implementation
Allow students to collaborate with each other	Students will work in groups during days one and two. During day three students are encouraged to work together to solve the math problems. On day four students can collaborate by sharing ideas for their graphs. For day five students will have one on one conversations about math with their peers.
Show the importance of math in daily life	Day one's purpose is show the students the value of mathematics in the real world and how math can satisfy human desires.
Explore of other parts of mathematics	Day one has math logic puzzles and explains how math is everywhere. Days two and three allows students to explore probability from hands on activities. Day five has students talk about their graphs.
Limit chalk & talk	All of the lessons are written to have five or less minutes of lecture for each day.

Personalize the material	<p>Each day has a different style of activity to get the most students engaged.</p> <ul style="list-style-type: none">• Day one will have a traditional slideshow, but include TikToks, logic puzzles, and pictures of math in the real world.• Day two has movement activities that are intended to be personalized for students who like sports or physical activities.• Day three is for people who like video games. The video game Google Snake is a favorite for students at LMS.• Day four involves art and being creative. Students will also have the option to draw their graph online or on paper.• Day five is intended to be fun for all of the students because it is a celebration of their learning. The students will get food and drinks which always is a hit.
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There were three pedagogies that did not get fully included in these lessons. They are: emphasize your mistakes, close the power gap between students and teachers, and be an advocate for changes in your curriculum. My plan is to continue to implement these pedagogies into my tutoring sessions by explicitly stating when I make a mistake, by allowing the students to have some control and teach me material, and by advocating for changes to my students curriculum to positively impact their learning.

2. Challenges

I went through many challenges throughout the thesis process including having to switch my host teacher and not being able to teach my lessons at Lewiston Middle School. My research approval form was not approved by the superintendent. The research approval form, Institutional Review Board (IRB) form, and Collaborative Institutional Training Initiative (CITI) forms are included in Appendix A. The approval process was the most challenging aspect of my thesis. At Bates College, students need to get IRB approval before they can start their research. Since the college was not allowing any in person engagement in the beginning of the semester unless approved by the IRB, I asked for guidance from the chair of the IRB. They informed me that once in person engagement was allowed that my project would fall under Exemption 1: Educational Settings and Normal Educational Practices. During this time, I had also started working on a research approval form that is required for public schools. The research approval form was signed by the host teacher and the principal and I was just waiting to hear back from the superintendent. Unfortunately, I ended up having to switch host teachers and I decided to resubmit the research approval form with the new signature was the right thing to do. I resubmitted and then faced some challenges during that process. After meeting with my new host teacher to discuss lessons and going into the classroom for over ten hours to observe, the form was ultimately not approved and I was unable to teach.

3. Future

Future research could consist of a similar activity to see if motivation and engagement improves when students' interests and activities

are involved. Another consideration would be to survey the teachers as well as the students because teacher surveys might be taken more seriously and have more valuable data.

I learned a lot from this thesis. Not just learning how to develop engaging lessons for middle school, but also learning how to communicate with others, learning that some things are just not in my control, learning how people prioritize different things, and learning that it is okay if your plans don't go as you had hoped.

“Go confidently in the direction of your dreams. Live the life you have imagined.” Henry David Thoreau

In the future I hope to continue to engage and motivate as many students as I can. After I graduate, I am going to continue to tutor and continually learn about how each individual learns best. Because yes, I am teaching the students, but they are teaching me so much more about education and how children learn best. I also plan to expand math tutoring to many other subjects and hire young aspiring teachers to work with me¹. Another plan for me is to develop my own curriculum with many subjects, including math that I think are the most important for students to learn. Lastly, two bigger goals that I have for myself right now are to open my own school and open a movement facility that incorporates physical exercise and math learning.

¹If you are interested in learning more about math tutoring here is my [website](#).

Appendix A. Forms

1	Institutional Review Board Approval Form	Appendix A 1
2	Collaboration Institutional Training Initiative	Appendix A 2
3	Research Approval Form	Appendix A 3

Appendix B. Lesson Plans

1	Lesson Plans	Appendix B 1
2	Teacher Note Packet	Appendix B 10
3	Student Note Packet	Appendix B 26
4	Pre-Survey	Appendix B 39
5	Google Slideshow Day One	Appendix B 41
6	Exit Ticket Day One	Appendix B 45
7	Exit Ticket Day Two	Appendix B 46
8	Exit Ticket Day Three	Appendix B 47
9	Google Slideshow Day Four	Appendix B 48
10	Exit Ticket Day Four	Appendix B 49
11	Post-Survey	Appendix B 50

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