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REAL-WORLD LEARNING IN MIDDLE SCHOOL MATHEMATICS

by

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A capstone project submitted in partial fulfillment of the requirements for the degree of
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DEDICATION

To my family and husband for their love and support and to my past teachers who gave me a passion for learning. I could not have done this without you.

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CHAPTER ONE

Introduction

Introduction

My goal as an educator is to shape my students into lifelong learners who have the skills to make them successful adults. I want to inspire young minds who thirst for knowledge. I know that math is all around us; it is why I have always loved the subject. I feel passionate about showing my students how valuable mathematics is. An issue I am aware of from my three years of teaching 5th, 6th, and 7th grade math is my students' inability to connect the math we do in class to real life. They see the numbers and can solve the equations when prompted, but they do not understand why it is important. They cannot transfer the numbers to real-life problems. As a result of these observations, I have decided to focus my action research on the topic of problem-solving in mathematics. Specifically, on how to get students to use real-world thinking to solve world problems. Word problems use math to connect to real-life situations. Based on my observations and focus, my research question for my capstone project is: *How does incorporating real-world word problems into weekly math curriculum in middle school affect students' learning, engagement, and understanding?*

This chapter outlines my rationale for incorporating real-world word problems into the math curriculum. This rationale is based on my own experiences and observations as a teacher. My focus is on the lack of real-world learning in school and the need to incorporate meaning into mathematics. This chapter gives context to my background as a teacher, and my experiences primarily from teaching fifth and seventh

grade mathematics. I will reflect on both my experiences as a teacher, as well as my experiences in school as a student. This chapter provides detail about the personal and professional importance of my research question. Lastly, this chapter summarizes my experiences and rationale and previews the remaining chapters of this project.

Rationale

When beginning to think of my research question, I considered what I wanted to improve on as a teacher. How could I become better? How could I improve the educational system? The first thing that came to my mind was making learning more meaningful in my math classroom. My middle school students can solve fractions and algebraic expressions, but they cannot always apply it to real life. As I thought more about my own lessons, I determined what I was lacking is real-world connections. Math is powerful if we know how to use it. Math is meaningful if we understand where we can use it in the real-world. An example of using math in the real-world would be when we shop for groceries and estimate how much money we spend or when we measure furniture to see if it will fit in a specific room in the house. I wanted to find a way to do this not only as one big yearly project, but weekly. This is when I came up with the idea of word problems. Can I use word problems in my classroom to get students to see math outside of the classroom walls?

Context

This topic of problem-solving in mathematics is important to me because I have always loved math. I grew up loving math because there was one answer. Solving puzzles and trying to work through long problems was fun to me. Math made sense. I used math

in my daily life when cooking dinner and measuring how much milk I needed. I used math when I helped my dad build a deck. I also used math when shopping with my mom and finding the best deals. Math was everywhere. My dad also enjoyed math and worked as an architect. We would have daily discussions about how he used math for his drawings. I knew math was important. I was good at it. I saw math in my world daily.

So how does my love for math connect to my profession of teaching? At 5 years old, I knew I wanted to become a teacher. I could not wait for the day when I could inspire learners just as my teachers inspired me. Up until sophomore year of college, I assumed I would be an elementary teacher. Then one day I met with my education advisor to discuss future plans. He asked why I had only considered elementary teaching. I mentioned my passion for math and the lack of enthusiastic math teachers I had in middle and high school. I had not felt inspired by them as I had my elementary teachers. I mentioned missing the strong, enthusiastic teachers in my middle/high school years. My professor asked why that would stop me from teaching math? He sparked a flame inside of me that day with the idea that I could be that strong and enthusiastic math teacher for others. I was encouraged to make not only teaching, but math, my calling from that point on.

This topic is professionally important to me. I currently teach 5th-grade math in a middle school setting. I have taught both 6th and 7th-grade math as well. My daily lessons often consist of me teaching a concept and then solving several simple number problems. Students' homework and tests are also focused on these same simple number problems. We usually complete one or two projects a year. Our curriculum is lacking

problem-solving opportunities because it is easier to focus on basic number problems for the sake of faster learning and lack of time (Pearce, Bruun, Skinner, & Lopez-Mohler, 2013, p. 4) Every fall, I notice that students forgot much of what they learned the previous year because they just memorized the content; they did not truly understand it. I constantly have students asking me *why* what we study matters. They only see math in the math classroom. They do not understand that math is in the world around them. This is why I want to find a way to make learning math more meaningful through problem-solving. I want my students to understand the *why* of mathematical learning. When students understand the why of learning math along with learning the concept, they can apply the knowledge they gain to solve new problems (Fennema & Romberg, 1999, Chapter 2). This can happen through real-world application of numbers. Students are more likely to remember and be engaged in the lessons they learn if it has meaning to them. I want to shape my students into problem-solvers and critical thinkers, and I am not doing this by using meaningless numbers.

As a middle school math teacher, I want math to make sense to my students, and I want them to see the value in learning math. I was fortunate to enjoy math and to have people in my life who helped me see the value of math outside of school. However, not all students have that opportunity. I was able to search for the math around me, but some students need help finding it. Math is all around us, as I have stated. Often, we do not see it because we are so focused on just solving the number problem. I want to help students discover how math makes up the world, and that math matters beyond just numbers. I want to give students critical thinking skills. Just as my parents made math part of my

daily life, I want to make it part of students' daily life as well. Real-world connections have many benefits, such as enhancing students' understanding of mathematical concepts, motivating mathematics learning, and helping students apply mathematics to real problems (Gainsburg, 2008, pp. 200-201). Something important to me is to incorporate problem-solving into math not monthly or quarterly, but weekly. Most importantly, I want to do this in a manner that is enjoyable for my students; something that makes math meaningful and fun.

Summary

In an effort to make math meaningful and engaging, I will be studying how incorporating real-world word problems into the weekly math curriculum affects students' learning, engagement, and understanding. I believe that by connecting math to word problems, we are creating meaning. I believe by adding problem-solving practice into the math curriculum, I am helping my students become better mathematicians. By making math meaningful and engaging, I am also making learning more enjoyable. If students find math enjoyable, they will have more curiosity and a desire to learn (Hersh & John-Steiner, 2011, p. 16). I have always had a passion for math. Math and my love of learning are what have gotten me to where I am today: loving my job as a middle school math teacher. Not every student I teach will love math, but I want every student I teach to know math matters outside of the classroom.

The following chapters explore the topic of word problems and real-world learning in mathematics. In Chapter 2, I examine the literature related to real-world learning in math. I explore in detail problem-solving, word problems, and understanding

in mathematics. Chapter 3 describes my project, specifically how it will be incorporated in the classroom. Chapter 4 is a reflection of my project and an evaluation of its success. Through my work, I hope to gain a better understanding of how to make math meaningful and connected to the real-world through word problems. I hope to explore how to do this on a weekly basis in a way that is engaging to students. I plan to share my knowledge with fellow teachers so we can continue to build a better real-world learning curriculum.

Not all of my students will grow up to be math teachers like me. Not every student I teach will love math. However, all of my students will understand math. They will see why math is important and find enjoyment in their learning. Overall, I want them to grow up knowing how to use math in everyday life and to be able to say “math matters”. I believe that math is everywhere and incorporating word problems into the math classroom is a way to get my students to realize that, too.

CHAPTER TWO

Literature Review

Introduction

Learning math happens in every school, every district, every day. Students are taught how to add and subtract, how to find area or perimeter, what the Pythagorean Theorem is, and more. However, what students are not often learning is problem-solving skills. They are missing how the math they learn in the classroom applies to everyday life. The challenge is how to make learning mathematics meaningful, related to the real-world, and engaging. The aim of this literature review is to better understand my research question: *How does incorporating real-world word problems into weekly math curriculum in middle school affect students' learning, engagement, and understanding?*

The research in this section provides an overview of what real-world learning is and what it looks like in the classroom. There is information on the issues surrounding real-world learning and why it is not commonly used in the classroom. There is also information on how problem-solving connects to the topic of real-world learning, strategies for problem-solving, and activities that involve problem-solving. Next, the research gives strategies and steps for solving word problems and explains challenges based on using word problems in the classroom. My capstone is about using word problems in the classroom and the effect they have. In order to know and understand if there are benefits, I need to deepen my knowledge about how word problems are utilized. This chapter discusses how to decode word problems and build the ability of students. It goes into detail about ideas for making math understandable through application and

what a classroom that promotes understanding and problem-solving looks like. Math can cause anxiety for many students, and I will discuss the effect that has on problem-solving and how it can be fixed. In order to understand all of the aspects involved in real-world learning and problem-solving as word problems, we must first explore what real-world learning involves.

Real-World Learning

What is Real-World Learning?

What is real-world learning? Real-world learning happens when what is learned in the classroom is relevant to everyday life. It allows students to see math outside of the classroom and understand the importance of learning math. Real-world connections have many benefits, such as enhancing students' understanding of mathematical concepts, motivating mathematics learning, and helping students apply mathematics to real problems (Gainsburg, 2008, pp. 200-201). Real-world learning helps students use what skills they learn in school to become engineers, architects, good money managers, and more. Real-world learning makes students care about mathematics because they see its importance.

Engaging students in real-world learning contexts is an important way of helping students apply what they have learned from textbooks to practical problems (Hwang, Chang, Chen, & Chen, 2018, p. 451). Real-world learning takes math out of the classroom and into the real-world. Students do not just learn how to find the area using the equation base times height, they learn how to find the area of a room so they know how much carpet they may need. They do not just learn how to add decimals but to add

decimals so they can determine how much money they spent on groceries. What are other examples of real-world learning? Real-world learning consists of completing projects that have students solving real-life problems. It is learning that involves solving word problems discussing real-life scenarios. Real-world learning is when a teacher models how to solve a problem a student might encounter in real life (Gainsburg, 2009, p. 265). Examples of this would be creating a budget for a trip, ordering food off a menu and calculating tip and tax, calculating how many yards you have yet to run to get a touchdown, finding the perimeter of a yard to know how much fence is needed, or calculating simple interest for a bank account. Real-world learning sounds uncontroversial—of course, it is beneficial, so we should use it. The problem? Real-world learning with meaning is often lacking in classrooms around the country.

How do we use Real-World Learning?

There is often an inconsistency between “school math” and “everyday math” (Boaler, 1993, p. 12). School math is solving problems on homework to complete it; everyday math is using math in real-life situations. Students learn how to solve math equations and problems for homework and assessments. What students often do not learn is why they must learn to solve these problems on their homework. They simply learn math so they can pass the math class and graduate high school. The teachers’ focus is on teaching math so students do well on the standardized tests (as cited in “Public policies push schools to prioritize creating better test-takers over better people”, 2018). Standardized tests determine how successful a school is, and in turn, affect school funding. Standardized test math questions are usually about finding the answer, but not

about why we need to find the answer. The tests “narrow” the curriculum so only basics are taught (Simpson, 2016, p. 1). There are very few real-world word problems. While students do not necessarily feel the direct pressure of the standardized test as their teachers do, they are directly impacted in the education they receive. A study published in *Educational Administration Quarterly* explained that, due to the importance of the results of standardized testing, the priority of schools on real-world learning, specifically job readiness, has decreased in recent years (as cited in “Public policies push schools to prioritize creating better test-takers over better people”, 2018). Instead of pushing teachers to include real-world learning in schools, pressure is on teaching to the test. There is enormous pressure on teachers to cover the material listed in the standards before the spring test. This pressure often leads to cutting projects or engaging activities that create real-world learning (as cited in “Public policies push schools to prioritize creating better test-takers over better people”, 2018). There is simply not enough time.

Another issue around real-world learning is the definition. What counts as real-world learning? When is it best utilized? Some teachers believe real-world learning is best used after the concept is grasped by students (Gainsburg, 2008, p. 216). For example: teach how to find the area before explaining when we might find the area outside of the classroom. However, the problem with this is students lose interest quickly. If a student does not feel there is a reason for learning something, they are easily bored and found to not care. “There is compelling evidence that everyday experiences provide a strong foundation for learning mathematical ideas” (Gainsburg, 2008, p. 216). In other words, there have been many studies that prove teaching while at the same time

connecting to real-life experiences is most beneficial. Learning a new topic, while at the same time supporting the topic with fun and real-world related activities, best helps learners connect and find meaning in their learning (Hwang, Chang Chen, & Chen, 2018, p. 452). Students do not learn if they do not care. Research suggests that we must get students to care by seeing the real-world importance and meaning in what they are learning as they are learning it.

Real-world learning in math is making math relevant to life. It is learning math inside the classroom that will have meaning to students outside of the classroom. Real-world learning makes math more engaging and fun for students because there are projects and activities, not just answers. Real-world learning activities combined with learning the topic in math is most beneficial. The issues that arise are timing and how. How can we incorporate real-world learning in the classroom so that it covers the standards, but also creates engagement and meaning? Where do we find the time to create this meaningful learning? What does real-world learning look like specifically in math? These questions will be explored in more detail in the following sections about problem-solving and more specifically, word problems.

Problem-Solving

What is Problem-Solving?

Problem-solving is the ability of a student to think complexly and creatively. It is the ability to not only seek an answer, but work to solve a problem. Problem-solving is what real-world learning looks like in the math classroom. It involves seeing a problem and having to think critically to solve it. Mathematics is being competent in

problem-solving. It involves taking a problem and using critical thinking skills to solve for an answer (Jäder, Lithner & Sidenvall, 2020). An example of problem-solving in math would be subtracting the decimals $5.12 - 4.10$; instead of simply subtracting, you would be given a problem to solve and think critically: *I have \$5.12 and I want to buy a bag of chips for \$4.10. How much money will I have left?* Another example of problem-solving would be when learning about data collection and graphing, have students create their own questions, survey their classmates, and graph the results. Lastly, an example of problem-solving in math could be when students are given a wrong answer to a question and they must determine what went wrong while solving. All of the examples go beyond simply solving a math number problem. They involve making a connection from the learning in class to actual problems you might see outside of the classroom. Problem-solving is real-world learning.

How do we Problem Solve?

Problem-solving is not something easily learned by students. This is because problem-solving involves reading, vocabulary, and critical thinking versus just using numbers (Dunlap & McKnight, 1980, p. 231). In fact, many students are used to only memorizing math facts and steps to solve equations. Much of math has been focused on arithmetic computation rather than higher-order thinking skills. Specifically for students who struggle with multistep problems (Ping Xin, Jitendra, & Deatline-Buchman, 2004, p.181). It is easier to get through the math material without taking time to focus on the specific language of math (Pearce, Bruun, Skinner, & Lopez-Mohler, 2013, p. 4) When asking students to solve problems that take creative thinking, they often do not know how

or where to start (Walter, 2009, p. 460). In exploring this, Ortiz (2016) did a study on the four-step process of problem-solving. In order to be able to problem solve, students must first be taught how to approach problems without a specific number equation. Students cannot solve a word problem if they do not understand it. Teachers must walk through the problem-solving process (Ortiz's four steps) many times with students to help shape their thinking as problem-solvers. Step one is understanding the problem. This is where student engagement comes in. Teachers must connect students to the problem by creating interest and real-world connection. Students must understand what is being asked/what they are trying to find. For example: are they trying to survey their classmates on how much homework they have each night? Are they trying to determine how much carpet they need to fit on the floor? In this step, it is crucial students understand the language of the problem. Understanding the language means studying keywords and knowing what the questions are asking (Pearce, Bruun, Skinner, & Lopez-Mohler, 2013, p. 12). They must understand the language culturally, socioeconomically, and timewise. Step two is devising a plan. This is when students reflect on if they have solved similar problems before. They ask themselves: what is the logical way of setting up this problem, and how will I find my answer? The third step is carrying out the plan. This is when students actually solve the problem, do the math, or collect the data. The fourth step is looking back (Ortiz, 2016, p. 8). This step is crucial in allowing students to analyze if their answers or results make sense. If not, they must start over with step two. This step also allows students to reflect on their own thinking. How did they approach the problem compared to their classmates? This is a great opportunity for class discussion on the

different ways everyone thinks about solving problems. In summary, in order to think critically and creatively to problem solve students must first learn how to understand the problem.

Teaching Problem-Solving

Problem-solving cannot be taught overnight; it is something that comes with practice, encouragement, and learning skills such as observation and understanding previous knowledge. Unlike memorizing an equation or type of problem, students must practice and learn how to analyze, understand the question, and learn procedural fluency (Jäder, Lithner & Sidenvall, 2020). How do we teach these skills? First, we must create a positive student and teacher relationship (Zhou, Du., Hau, Luo, Feng, & Liu, 2020, p. 474). Mathematics is often a subject that creates anxiety and feelings of failure, so students need to feel safe to learn (Boaler, 1993, p. 15). Having a positive classroom environment where students feel free to take risks, try new things, and stretch their thinking is key to problem-solving. Students must be encouraged that they are able to do math regardless of what they have been previously told (Kaskens, Segers, Goei, van Luit, & Verhoeven, 2020). Also, students must practice problem-solving frequently (Pearce, Bruun, Skinner, & Lopez-Mohler, 2013). Students must be given the chance to create their own ideas and conclusions. They must be given math problems where they are not told how to solve, but they are told to discover how to solve. Meaningful and engaging practice frequently in the classroom will lead students to become strong problem solvers of real-world problems (Gainsburg, 2008, p. 203).

Most mathematicians begin showing interest in mathematics around middle school. These young mathematicians were inspired by people around them. They developed curiosity and a desire to learn (Hersh & John-Steiner, 2011, p. 16). This is what students must have in order to become problem solvers. They must be given the opportunities and be taught the skills to problem solve. The section on problem-solving has gone into detail about what these skills are and what problem-solving can look like in the classroom. The issue is where do we find this time in the standardized test-driven education? Projects are beneficial but time-consuming. In order to address both of these questions, I will introduce my next section about word problems. My research question is about how to use problem-solving in the classroom weekly through word problems. The section on word problems will explore a way of problem-solving that does not take extensive time in the classroom, but makes real-world connections and involves problem-solving.

Word Problems

Word Problems in the Math Classroom

Real-world learning in the classroom using problem-solving is beneficial. It allows students to think creatively and make connections from the math classroom to real life (Jäder, Lithner & Sidenvall, 2020). However, how do we incorporate problem-solving in the math classroom while effectively using time and getting through the necessary material? One answer is by using word problems. My research question is about the effect of word problems in the weekly math classroom. Word problems provide real-life scenarios using the math learned in the classroom. “In the school curriculum, word

problems allow one means by which students can work toward developing problem-solving skills within contextualized settings that do not require application of rote procedures” (Bates & Wiest, 2004, p. 17). A word problem goes beyond just solving numbers, but placing these numbers in a real-life scenario. Word problems are a way for students to learn mathematics material in a real-world scenario that does not just involve rote memorization. Rote memorization is when students learn to solve equations and complete number operations without meaning through memorization of the process (Daroczy, Wolska, Meurers, & Nuerk, 2015, p. 17). An example of rote memorization would be learning/memorizing the equation to find the area of a rectangle, but not when to apply it. Students must apply what they are learning in math and use the skills to successfully solve a real-life problem and make a meaningful connection. Word problems are also a beneficial type of problem-solving because they are not long projects, but short problems that can easily fit into the daily curriculum.

An example of a word problem used in the classroom would be the following: A middle school class is studying how to find the area of a rectangle. Students have learned how to use the equation $\text{area} = \text{base} \times \text{height}$ and are then given word problems to practice. An example of a word problem is “Johnny wants to put carpet down in his new room. The length of his room is 10 feet, and the width of his room is 12 feet. How many square feet of carpet does Johnny need to cover the floor?” In this word problem, students are not only finding the area, but also seeing when they would find the area of something in real life. The math concept has a real-world connection. The task involves taking a problem and using critical thinking skills to solve for an answer (Jäder, Lithner &

Sidenvall, 2020). This is a situation students can relate to and may encounter in real-life. After solving this problem, a class discussion could be held around when students have used money to buy things and calculate cost in their own lives. Students need to understand the meaning behind a math question; they need to know what they are solving is relevant. They should not just rote memorize or solve because they are told to do so.

Current Issues Involving Word Problems

Word problems are used in most math classrooms, but often have a negative connotation. Many students do not like solving word problems. They do not result in problem-solving, but more confusion. Why? Researchers Bates and Weist (2004) pointed out how there are three main reasons why students have little success in solving word problems: limited experience, lack of motivation, and irrelevance to students' lives. Before looking at successful implementation of word problems in the classroom, it is important to look at ineffective uses of word problems. First, because word problems take higher-level thinking skills and more effort to learn, they are often skipped altogether. Students are not exposed to word problems frequently, so they do not learn the necessary skills to solve them. A simple solution to this is more exposure. Students need to be challenged and taught to use critical thinking skills on a daily basis. The issue of time is not as prevalent because word problems can easily be fit into the daily curriculum. Working on finding an area? Come up with a word problem around the problem students need to solve. For example: instead of asking students to find the area of a rectangle, using the equation $\text{area} = \text{base} \times \text{height}$, with a length of 10 feet and a width of 12 feet, have students find the area of a small room with 10 feet x 12 feet sides so they can see

how many pieces of furniture they can fit in the room. The issue of limited experience can be solved if teachers use word problems more frequently in the classroom. The need for more exposure to word problems is why part of my research question includes *incorporating real-world word problems into weekly math curriculum*. Word problems, to be used efficiently, need to be used frequently and meaningfully.

Another issue surrounding word problems is students often have a lack of motivation to solve word problems because they are not interested or the problems are not relevant to them. Students need to be interested in the problem they are solving in order to be motivated to solve the problem (Bates & Wiest, 2004, p. 17). Students want to learn things that seem relevant to their lives. If they play football, they want to learn the math around football. If they like gardening, they might be more interested in word problems about gardening. Questions personalized to students' lives tend to be particularly effective in fostering positive attitudes toward word problems (Bates & Wiest, 2004, p. 18). If teachers take time to create word problems including their students' names, interests, and questions, students will be more interested and have more motivation to solve them (Pearce, Bruun, Skinner, & Lopez-Mohler, 2013, p. 9).

Word problems involve not only math skills, but literacy skills as well. This often makes them more challenging. Comprehending the language of a word-problem is crucial to being able to understand and solve them (VanSciver, 2009, p. 1). Students must understand what the question is asking and what all words mean in the word problem in order to solve correctly. Often, math word problems involve “verbal cues”, which are words that tell you to do a certain math operation. For example, “and” for addition,

“difference” for subtraction, and “part of” for fractions (Daroczy, Wolska, Meurers, & Nuerk, 2015). It is unsuccessful to use word problems in the classroom without teaching the language behind them. A teacher must teach these cues and the language in the word problem in order for a student to learn how to solve them. This understanding and learning come with practice and application. Using notebooks to write down math vocabulary is beneficial in teaching the language of word problems (Pearce, Bruun, Skinner, & Lopez-Mohler, 2013, p. 10). An example of how to do this would be when studying solving equations, discussing how difference means subtract, and then point this out in several word problems. Have students write it down. Circle the “verbal cue”, and put a math sign above it (+,-,x,/). Think about how finding the difference between two heights means subtracting them. The more word problems are used in the classroom, the more the language comes naturally, similar to using new vocabulary in an English class.

Successfully Using Word Problems

After knowing how to attempt and conquer the challenges of using word problems in the classroom, it is important to learn strategies that will best lead to student understanding and success. Several ways to use word problems in the classroom are to identify key words, draw a picture, outline steps, and to reread. (Pearce, Bruun, Skinner, & Lopez-Mohler, 2013, p. 9). Identifying key words means knowing all of the vocabulary, and knowing vocabulary that has a certain meaning in math-key words (Daroczy, Wolska, Meurers, & Nuerk, 2015). Drawing a picture allows students to see visually what the question is asking. Outlining the steps helps students know what the question is asking in each part, and rereading often makes the wording and question

clearer. If taught using these strategies, as well as connecting to students' lives', word problems can be very effective in getting students to see math in a real-world setting.

My research question focuses on the topic of word problems. This section highlighted how word problems are ways of problem-solving in the classroom. Word problems allow students to solve real-world problems because the word problems they solve can directly be tied to real life. Word problems are most successfully used if they relate to students' lives, the language is understood, and students are taught to think critically (Bates & Wiest, 2004, p. 18). These are all important ideas I will use when planning my word problem unit. A significant part of using word problems and problem-solving in the math classroom is the ability to understand. This can include understanding the language used in word problems or understanding at different ability levels. The next section will explore ideas for making math word problems understandable, through application and what a classroom that promotes understanding and problem-solving looks like.

Understanding

“ Learning requires a solid foundation from which to build and expand”
(Meaningful Mathematics, Leading Students Toward Understanding and Application, 2020). Throughout this chapter, I have discussed how real-world learning is valuable to students because it allows them to see the math they learn outside of the classroom. They are able to understand the relevance of mathematics. I have also discussed how to use problem-solving, specifically word problems, in the math classroom. In this section, I will focus on the topic of understanding. This has briefly been touched on in other

sections when discussing how to teach students word problems with specific language and the why behind real-world learning. However, in this section, I will go into more detail about understanding. In order to solve word problems, think critically, problem-solve, and make real-world connections, students must first and foremost understand the math problems. This section will connect real-world learning, problem-solving, and word problems altogether.

Students learn math in classrooms around the world on a daily basis. They learn how to add fractions, count money, learn their basic facts, and solve calculus equations. However, in a math classroom, students should not just do; they should understand. “When students acquire knowledge with understanding, they can apply that knowledge to learn new topics and solve new and unfamiliar problems” (Fennema & Romberg, 1999, Chapter 2). When students solve multiplication problems, they are showing they can memorize and complete a process. When students see a multiplication word problem and first understand the language, then determine the process to solve, and lastly solve, they are understanding math. They are connecting the process they “rote memorized” and show understanding by applying the concept (Jäder, Lithner & Sidenvall, 2020). Real-world connections enhance students’ understanding of mathematical concepts (Gainsburg, 2008, pp. 200-201). Real-world learning allows students to truly understand math beyond simply solving.

Developing Understanding

How do we develop this understanding? Using word problems in the classroom is only effective if students are taught how to navigate them (VanSciver, 2009, p. 3). We

cannot give students word problems and expect them to make real-world connections themselves. In fact, we cannot give students word problems and expect them to understand them at all. This understanding must be taught. Fennema and Romberg (1999) discussed in their book, *Mathematics Classroom That Promotes Understanding*, ways understanding is developed in students and in a classroom (Chapter 2). First, teachers must help students construct relationships between things or topics they already know and things or topics they are learning. For example, when discussing subtraction and the verbal cue “difference”, it is helpful to discuss something students understand such as measuring height (Daroczy, Wolska, Meurers, & Nuerk, 2015). A teacher could have two students stand up, and discuss how when finding the difference between the two heights they want to find the amount between their heads. Students can see the term “difference” in a form they understand and can visualize.

Another way understanding is developed is through reflecting about experiences and articulating what one knows (Fennema & Romberg, 1999). While solving a problem, and after calculating, it is crucial students take time to reflect on what they just solved. How did they complete the process? How did they use what they knew to solve something they did not know? Reflecting on knowledge allows students to be more aware of what they know and what they are learning (Fennema & Romberg, 1999). A way to do this in the classroom is after solving a word problem, have students share their thought processes. What did they do? How did they know which step to take what previous knowledge helped them? Allow students to build off of one another. Learning math

vocabulary is a large part of this section (Pearce, Bruun, Skinner, & Lopez-Mohler, 2013, p. 10). Students can only understand if they can articulate what they learned.

One last way understanding is developed is through making mathematical knowledge one's own (Fennema & Romberg, 1999). This simply means taking responsibility for learning and forming one's own conclusions. Understanding comes when a student can hear what others say, but still form their own assumptions and learning (*Meaningful Mathematics, Leading Students Toward Understanding and Application*, 2020). An example of this would be discussing how different students solved a problem, but still allowing each student to reflect on the way they did. What did they do correct or incorrect? What did they learn through their own problem-solving method? Where do students see this math happening in the world around them? Understanding allows students to take what they learned outside of the classroom because they know what they learned and why.

The Role of Anxiety

Anxiety and math are two words often heard in the same sentence. Math is a subject that is constantly building off previous knowledge. For example: in order to add fractions students must understand factors, to understand factors they must understand multiplication and division, to understand multiplication and division they must understand addition. Once a student struggles with a concept in math, it is hard to continue without gaining back understanding. Everything is connected. It is easy to fall behind in math. Poor math skills correlate with high anxiety. Students who struggle with math are anxious because they feel as though they are incapable (Kaskens, Segers, Goei,

van Luit, & Verhoeven, 2020, p. 2). These feelings of anxiety can come from a variety of places: teacher incompetence, lack of understanding at a young age, parental influence, etc. (Kaskens, Segers, Goei, van Luit, & Verhoeven, 2020). Students cannot gain understanding and cannot solve real-world problems if they have the mentality that they cannot.

This all comes down to the classroom environment and teachers. Students can only learn if they feel welcome to make mistakes and take risks (Boaler, 1993, p. 15). Even if students are not proficient in math, does not mean they should be made to feel this way. Students need teachers who believe in them. Teachers who encourage wrong answers because they show learning. If a teacher has a positive attitude toward mathematics, as a result, students are more likely to feel positive as well (Kaskens, Segers, Goei, van Luit, & Verhoeven, 2020). Students also need teachers who connect math learning to their lives so it is interesting and fun (Pearce, & Bruun, & Skinner, & Lopez-Mohler, 2013, p. 9). A combination of teachers who show passion for math, a welcoming environment, and relevant learning will make students less anxious and more excited to learn math. All students can learn math. However, they must be given the confidence in themselves to believe they can.

Different Abilities

Students in math class will all have different abilities. Some may be above grade level, some at grade level, and some below. A teacher's job is to create understanding at all levels of learning. This is no easy task, but the idea of understanding is relatively simple. The best way to start is by creating general interest in math (Jäder, Lithner &

Sidenvall, 2020). Students with lower levels of understanding may need more time and assistance along the way, but understanding for students will come through the same process of connection, using previous experiences, learning new processes, and time. A teacher focused on reasoning and problem-solving is able to help all learners of all levels (“Linking Teacher–Learner Discourse With Mathematical Reasoning of Students With Learning Disabilities”, 2020, p. 52).

Understanding is an important part of my capstone. Solving word problems can only happen if students gain understanding in the process. They must understand the language of math, the question they are answering, their own thinking, and their previous knowledge. Real-world learning comes through deeper understanding that math exists outside of the classroom. Once students see this, the possibilities of where math can take them are endless.

Summary

Learning math happens in every school, every district, every day. However, math also happens outside of the classroom every single day in many different forms. Math is when a construction worker measures a window, when an engineer calculates the efficiency of a machine, when a person budgets for groceries, and when a student solves for the area of a triangle. In order to understand the importance of math, students must be taught problem-solving-skills in the classroom so they can use real-world learning to see the math surrounding them. Learning mathematics is meaningful because it is related to the real-world. Relating math to the real-world is what makes it engaging. The aim of this literature review was to better understand my research question: *How does incorporating*

real-world word problems into weekly math curriculum in middle school affect students' learning, engagement, and understanding?

The research in this section provided an overview of what real-world learning is and what it looks like in the classroom. There was information on the issues surrounding real-world learning; why it is not commonly used in the classroom and how to change that. There was also information on how problem-solving connects to the topic of real-world learning, strategies for problem-solving, and activities that involve problem-solving. This chapter discussed how to decode word problems and build the ability of students. It explored the value of using word problems frequently to provide problem-solving opportunities in the classroom. Research examined the anxiety math can cause for many students and the effect that has on problem-solving ability, strategies and steps for solving word problems, and different abilities of students. Lastly, this chapter went into detail about ideas for making math understandable through application and what a classroom that promotes understanding and problem-solving looks like.

The information in this chapter supports the idea that real-world learning through problem-solving in the classroom is highly beneficial. Word problems have been proven to be a useful way of problem-solving in the classroom in a timely and effective manner. Word problems allow students to solve real-world problems because the word problems they solve can directly be tied to real life. Creating personalized word problems that connect to students' interests is something worthwhile.

Chapter three will introduce my project around word problems. It discusses how word problems will be used weekly in my classroom to create learning, engagement, and

understanding. A curriculum where word problems are incorporated will be created. This curriculum will also include how to teach vocabulary and skills needed to solve word problems. Chapter three outlines this project, its context, and its intended goals.

CHAPTER THREE

Project Description

Overview

Math is everywhere. It is used when grocery shopping and finding cost, when measuring dimensions of a room, when determining the tip at a restaurant, when estimating calculations, when reading graphs, and more. It is extremely important students understand that math is used every day outside of the classroom. Students will see math as engaging and meaningful if it is taught as such in the classroom. Math is best taught with meaning through real-world learning opportunities, problem-solving, and real-world word problems.

My research question for my capstone project is: *How does incorporating real-world word problems into weekly math curriculum in middle school affect students' learning, engagement, and understanding?* After reflecting on the research completed in the literature review, I have created a math word problem curriculum, “Word Problem Wednesday”, to be used in my own math classroom to create real-world learning opportunities through problem-solving. This chapter provides an overview of my capstone project including a summary of research and theories which support my project. The audience, setting, and timeline of my project is also discussed in this chapter to give detail of how my project was carried out in the classroom. Lastly, this chapter will preview the final chapter of my capstone, chapter 4. Word problems are beneficial for problem-solving in the math classroom, now it is time to determine how to incorporate them.

Project Description

I teach 5th-grade math at a middle school level, and I have noticed a lack of understanding of word problems related to problem-solving in the classroom. Students do not know how to solve word problems, and are rarely exposed to them in everyday curriculum. Word problems come last on our list of items to teach and only if there is time. The curriculum I have developed is based on the need for a curriculum where word problems are purposefully incorporated weekly with meaning while creating understanding. The curriculum I have developed can be used along with other math curriculums as a supplemental tool.

I have created a word problem curriculum to be incorporated throughout the school year in my 5th-grade math class. It is called “Word Problem Wednesday.” Every week on Wednesdays at the beginning of class, students will be given five word problems to solve and submit on the learning management system Schoology. These word problems review previous math concepts and/or are based on the math we are currently studying. Students' hobbies, interests, and names are incorporated into the word problems to create a high interest. As we start the year, we go through the word problems together as a class. While completing the problems, we discuss and take note of certain vocabulary/key words. We write down steps and strategies to solve each word problem, connect to problems we have previously solved, and discuss the real-world connection. There are discussion questions each week to make real-world connections as a class and to deepen understanding. As the year progresses, students become more independent in “Word Problem Wednesday.” They sometimes work independently and sometimes with

small groups. This curriculum activity takes the first fifteen minutes of class each Wednesday. There are a total of 30 word problem lessons in this curriculum. The word problems used each week correspond to the units I am currently teaching. For example, when working on subtracting fractions, several of the word problems for that week incorporate subtracting fractions. There are also problems from previous units and 4th grade standards to review previously learned concepts.

Framework

The school district I teach in has a curriculum based on 21st Century Readiness. This is a focus on “initiatives that fuse core academic subject knowledge and higher-order thinking skills (such as critical thinking and problem-solving, communication, collaboration, creativity, and innovation) to ensure that students are prepared for postsecondary education and careers, upon graduation from secondary school” (Petri, 2013, p.1). 21st Century Readiness means our goal is to ensure students are ready for a changing world where they can be problem solvers and strong employees. The goal in my district is to ensure our students have the tools they need to succeed after they leave the building. We have also adapted the Rigor and Relevance Framework where the focus is on gaining knowledge to be applied in other contexts (Rigor/Relevance Framework, 2020). My curriculum focuses on relevance because word problems are about making math relevant to real-life. This relates to real-world learning because real-world learning teaches students how to solve a problem they might encounter in real life (Gainsburg, 2009, p. 265). In my curriculum project, 21st century skills, relevance, and real-world learning appear in the form of word problems.

Research done by Bates and Weist (2004) discusses the benefits and research behind personalizing math word problems and the benefits for students. Their research goes into detail on how personalizing word problems and making them interesting to students leads to increased understanding. It also describes the benefits of personalization over simply using problems from the book/curriculum. When creating word problems for my project, I personalized word problems because of what this research supports. Students can connect their learning to their own lives; this is 21st century learning.

Another study I found goes into detail about beneficial methods to use when solving word problems in the classroom (Pearce, Bruun, Skinner, & Lopez-Mohler, 2013, p. 4). These strategies include but are not limited to: making a plan, vocabulary, and background knowledge. When creating my curriculum I incorporated these methods into how I taught and approached “Word Problem Wednesday.” This research supports frequently using word problems in the classroom and teaching how to approach them, versus just memorizing. These strategies allow students to move past simply solving math problems but using them in real life. This research also helped determine how I evaluate my curriculum and students' success: based on correct understanding of vocabulary, correct answers, and growth. Once again this all relates to 21st century skills because students are given math problems to prepare them for real life situations (Petri, 2013).

Setting and Audience

My school has approximately 550 students in grades five through seven. It is a small town district. The district I teach in is not very diverse in ethnicity; the majority of students identify as white. According to the Minnesota Department of Education, 86.2% of students in my school district are white (Minnesota Report Card, 2020). However, my school and district are very split socioeconomically. Students are either high or low class, with very few in between at middle class level. This is shown through our data that 36% of students receive free and reduced lunch (Minnesota Report Card, 2020). Although this number is not high compared to many schools in Minnesota, it is one data point showing the diversity in socioeconomic status of our students. This causes a strong divide in students' opportunities and expectations outside of the classroom. This socioeconomic difference was something I was made aware of when I interviewed for the job at my school. There is a high priority on standardized testing in my district, and we pride ourselves on being high ranking in the state. In 2018, 78.5% of students at my school met or exceeded state standards for math standardized tests. This is compared to 63% passing on average state wide (Minnesota Report Card, 2020). Although this is wonderful, the priority we place on standardized tests can often mean less focus on problem-solving and real-world learning. However, the district I teach in is working hard to place a strong focus on real-world learning, with a specific focus this year on the Rigor/Relevance Framework (Rigor/Relevance Framework, 2020). My curriculum project relates specifically to relevance, as it focuses on making math learning relevant through word problems and problem-solving practice.

The audience of my curriculum project is my own fifth grade math classes. The students I teach are between the ages of ten to eleven. In my classroom 97% of my students are white and only 2% of my students are considered high risk for math performance based on state testing from the fall (Viewpoint Data from District). Students in fifth grade are just entering middle school and are switching classes throughout the day for the first time in their educational career. I have about 55 students in my two math classes who used the curriculum I created. As stated previously, I added the “Word Problem Wednesday” curriculum into our current curriculum as an additional supplement.

Assessment

An important part of a curriculum is assessment. Based on my research question, I want to ensure I am assessing learning, engagement, and understanding. Assessment of learning in this curriculum is the graded five word problems each week. Sometimes students are graded on participation, other times on correct answers with labels. This grading allows me to monitor how students are performing each week. I assess understanding based on students' scores. If they are performing well, they are learning.

Assessment of engagement comes in several forms. Informally, I observe students as they work on the word problems and monitor: *Do students seem interested by the questions? Are they understanding the language? Do they have a desire to find an answer?* I also have students fill out informal surveys throughout the implementation of the curriculum. *What do they like? What types of questions interest them? What do they want to learn more about? What would make “Word Problem Wednesday” more*

engaging? Student feedback is an important part of engagement as it allows me to see how my students believe they are doing and what they enjoy.

Lastly, I assess understanding. I do this similarly to how I assess learning. If students are understanding, they should perform well on the five word problem assessment. If students are understanding, they should be transferring the knowledge from week to week to each new word problem. Assessing learning, engagement, and understanding will give me a wide overview of how students are problem-solving. Successful learning is not just a high letter grade, but also a transfer of knowledge and a feeling of understanding.

Timeline

The timeline I created for this project was to begin creating my project in late January to early February 2021. When developing my project I created math word problems, vocabulary, the structure of curriculum, decided how to present to students, and created student engagement surveys. My curriculum project was implemented in my own 5th-grade math classroom in March of 2021. Each Wednesday we did “Word Problem Wednesday” including solving five problems, discussing vocabulary, answering questions, and making real-world connections. In April of 2021, I reflected on the effect of student understanding and performance with the addition of my word problem curriculum. As spring continued and the school year wrapped up, I continued to reflect on, adapt, and use “Word Problem Wednesday”. My plan is to continue using this throughout the 2021-2022 school year.

Summary

The project I created, “Word Problem Wednesday”, brings problem-solving to life in the classroom. It is weekly incorporated word problems that directly relate to real-life situations. Word problems that are used frequently and are related to students' interests will increase learning, motivation, and understanding. The curriculum I have created relates to my school's curriculum of 21st Century Readiness and is supported by other key research in the field on word problem strategies and methods, as I have described in this chapter. Chapter three discussed how my project builds on our school framework of Rigor/Relevance. My setting and audience of 5th-graders in a middle school math classroom have been identified, as well as my timeline for the project. Overall, chapter three connected my background and rationale from chapter one and the supporting literature in chapter two to explain how I created a project related to word problems and real-world learning.

In chapter four I will reflect on the project I created, its successes, and its challenges. I will also describe my next steps in adapting my curriculum based on the insight I gained. Chapter four will be a conclusion to my research capstone project on how incorporating real-world word problems into the weekly math curriculum in middle school affects students' learning, engagement, and understanding.

CHAPTER FOUR

Conclusion

Overview

“Math is everywhere.” Almost everyone can remember a math teacher telling them that fact at least once in their educational career. The question is, can we really see it? As I stated in my introduction to this project, my goal as an educator is to shape my students into lifelong learners who have the skills to make them successful adults. I want to inspire young minds who thirst for knowledge. I know that math is all around us; I can see it. My hope is that I can help my students see math in their world as well so they understand its value.

An issue I have seen in my own math classroom is students' inability to take what we learn in math class and apply it to real-world situations. This is why I decided to focus my research question on the topic of problem-solving in mathematics. Specifically, on how to get students to use real-world thinking to solve world problems. Word problems use math to connect to real-life situations. My research question for my capstone project is: *How does incorporating real-world word problems into weekly math curriculum in middle school affect students' learning, engagement, and understanding?*

In this chapter I will reflect on my project, Word Problem Wednesday. I will discuss the successes and challenges I faced while creating this project. Word Problem Wednesday was implemented in my 5th grade math classroom, and in this chapter I will share the affects the curriculum had on my students. This chapter will review some of the literature from Chapter 2 and how it supported the project I created. I will also discuss the

implications and limitations of my project as well as what next steps this project has encouraged me to take for creating math curriculum in the future. My Word Problem Wednesday curriculum was created to bring real-world learning into my math classroom, so how did it go?

Creation and Implementation

I have learned a lot about myself as a researcher, curriculum writer, and learner throughout this capstone process. I have always been passionate about mathematics, but I had no idea that there were so many other people in the world who wanted to study mathematics in education. When writing Chapter 2, I was inspired by the amount of studies and research done around mathematics, specifically in terms of real-world learning and problem-solving. I feel that I became a better researcher as I worked on my capstone project. My ability to analyze existing studies and determine the main idea of a 100+-page paper was strengthened. I feel I was able to grow as an educator through my own research as I learned about new teaching techniques and came up with new ideas to implement in my project and classroom.

Curriculum writing was challenging for me. Starting from scratch and having to create 100's of word problems took significant time, thought, and effort. My biggest challenge was creating a curriculum that could be used by other teachers. It took many edits to create a curriculum with enough details and guidance for another teacher to be able to understand and use my curriculum. Creating my own curriculum made me more appreciative of the curriculums I use each day in my classroom; they are useful and user friendly.

I was able to implement my Word Problem Wednesday curriculum over the past two months in my classroom, and I was happy with the results. We did the first 6 weeks of the curriculum. When I first introduced the idea of Word Problem Wednesday, my 5th grade students were not excited. Word problems have a negative connotation of being difficult and not “fun”. I started the unit off by explaining to my students why we were studying word problems each week. We discussed how we would complete five word problems a week and dive into how they are related to their lives. Each week we discussed the problems, the vocab, and used the discussion questions. After a few weeks I noticed my students beginning to expect Word Problem Wednesday and show some excitement about it. What were we going to talk about today? Unlike our normal math curriculum, Word Problem Wednesday brought variety to our math class. It pushed and challenged my students to think critically. I had many students struggle with solving the word problems to start, but I saw improvement each week as students began to learn the key words and how to analyze and find the important information. Overall, I was very pleased with the implementation of my curriculum.

Literature Review

My initial research for my capstone project was broad. I looked at every source I could find about math, curriculums, and real-world learning. As I deepened my research, I found many great resources about the importance of problem-solving in the classroom, real-world learning, and word problems. There were several sources from my literature review I found most helpful and important for my capstone project. Gainsburg’s research

on the benefits of real-world learning guided me in deciding what my capstone project would be focused on. He discusses benefits of real-world learning such as enhancing students' understanding of mathematical concepts, motivating mathematics learning, and helping students apply mathematics to real problems (Gainsburg, 2008, pp. 200-201). His research solidified my idea to focus my capstone on real-world learning in math.

Research done by Ortiz allowed me to enrich my project. I knew I was going to do something with word problems. I knew how to create word problems. What I was missing was how to make word problems into a curriculum on its own. Ortiz's research about the steps for problem-solving and the importance of understanding vocabulary and what the question is asking led me to adding in my "key words" and "questions" section in my curriculum (Ortiz, 2016, p. 8). His research demonstrated the importance of taking time to teach HOW to solve word problems.

The last research that I found most important for my capstone was by researchers Bates and Wiest. Their research was focused on the need for student interest in word problems. Students need to be invested in their learning for it to be valuable. Word problems are most successfully used if they relate to students' lives, the language is understood, and students are taught to think critically (Bates & Wiest, 2004, p. 18). This research led me to create word problems that relate to my students lives. The word problems I created include students' hobbies, interests, and names. This is what makes my curriculum different from word problems found in a textbook; they have meaning and connection.

Looking back at my research now that I have created my project, I have made many new connections. I better understand why every article on word problems was tied into problem-solving and real-world learning. Word problems are all about problem-solving and if used correctly, they encourage real-world learning. Now I see the importance of my understanding section of research. Without understanding, a curriculum with word problems is useless. Students must be taught how to analyze, find key words, and answer higher level questions in order to understand. The biggest connection I have made is that understanding is the key idea to successful mathematics.

Implications and Limitations

My hope is that my capstone project and the curriculum I created can be useful to other teachers. I strongly believe in the importance of real-world learning in mathematics. The Word Problem Wednesday curriculum is a way to ensure that math is being taught in a real-world context on a scheduled basis. Students are encouraged to use higher thinking and to see math outside of a workbook. An implication of my project is engaging more students in math application and STEM fields. My individualized word problem curriculum allows students to see more of themselves in real-world math. Because this curriculum is teacher created and adapted, students of all races, genders, and backgrounds can see themselves represented in word problems; it is an equitable curriculum. I do not believe my project will have any policy implications, but I do believe it could encourage other teachers to use word problems in a more meaningful way in the classroom.

The biggest limitation of my project is that it only covers five problems a week. Students should be learning math in a real-world context daily. They should be taught to

see the usefulness of math for every lesson. My project/curriculum does not incorporate hands-on projects, and that is something, after researching, I see significant value in. My curriculum is great in terms of structure and consistency, but lacks variety and opportunity for student creativity. Something I would like to add on in the future is more opportunities for students to create their own word problems.

Next Steps

Despite some limitations of my project, I am happy with what I created. I feel it is a needed and useful curriculum for math teachers. This project has inspired me to continue my research in the field of mathematics. I believe there is still so much I have to learn about real-world learning and application in the mathematics classroom. Something I am interested in researching in the future is what ways I can incorporate problem-solving in the classroom beyond word problems and big end-of-the-year projects. Creating a second curriculum/ resource about problem-solving beyond word problems is something I would like to pursue. I am also interested in learning more about making real-world connections in classes like higher level Algebra and Calculus because this math is not often used on a daily basis. I often wonder, unless you become a mathematician or engineer, what is the point in learning about Calculus? How could I make higher-level math just as real-world?

My journey with my Word Problem Wednesday curriculum is only just beginning. I plan to use this curriculum next year in its entirety. I want to see long term results of using meaningful word problems in the classroom. I will use the results I get off of scores and student feedback to continue to edit and improve my curriculum for the future. The

Word Problem Wednesday curriculum will be shared with my colleagues so they can utilize this in their classroom. I would be interested in leading a team meeting about what I have created. Getting feedback from other math teachers can only make my curriculum better.

I believe my capstone project is a benefit to teachers everywhere. Even if they do not teach 5th grade math, my hope is that this project will encourage them to step beyond the regular curriculum to enhance students' learning opportunities. Most of all, I hope this curriculum will show students and teachers the importance of math. Math is everywhere, and this curriculum is the first step in showing this.

Summary

I have always been passionate about mathematics. Math is the foundation of our world, and we all need to see that. My capstone project has increased my excitement and interest in math. I have a stronger desire than ever to spread my love for math to my students. In this chapter I discussed the successes and challenges I faced while creating this project. I shared the affects the curriculum had on my students. This chapter reviewed some of the literature I found most important from Chapter 2. I explained the implications and limitations of my project as well as what next steps this project has encouraged me to take. In this paper I was able to share my journey of brainstorming, researching, forming, and creating my capstone project, Word Problem Wednesday.

As I said in the beginning, not all of my students will grow up to be math teachers like me. Not every student I teach will love math. However, I am more confident than ever after my research and the curriculum I created, that all of my students will

understand math. They will see why math is important and find enjoyment in their learning. At the end of the day, my students will understand that “math matters”.

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