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Mathematical Perceptions: Changing Mindsets in Elementary School Classrooms

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Abstract

In classrooms throughout the country, you can hear students moan about the difficulty in learning mathematics. This senior capstone examines the students' mindsets about mathematics in Monterey County through the use of literature review, classroom observations, and interview with teachers. The findings reveal that students' mindsets can be changed over time if teachers have the right tools and appropriate training to help students.

Introduction

"Math is logical, predictable, and it makes sense" (Teacher Interview, appendix A). Many students and even some adults look at a math problem and they start thinking ‘oh no how am I going to do this' or ‘I do not remember how to do this' and that thinking is not a good way to be successful. Many students in school dread the thought of going to school because they have to do math at some point during their day.

My research idea came from a few different aspects of thought. The first being in a Math 309 class that was taken at California State University, Monterey Bay. The professor of this class was very energetic and encouraging. She wanted to help erase the stigma that math was only for some people. This energy from her inspired me. The second was a group of elementary school students in a class that I completed service learning in. I was in the classroom during this math instruction time and noticed that almost all of them had very negative attitudes towards math. This lead to my primary research question. An author on a book about growth mindset and mathematics, Boaler (2015), wrote in her book *Mathematical Mindsets*, two key points that fit into the idea of mindsets and mathematical thought. The first being "If brains can change in three weeks, imagine what can happen in a year of math class if students are given the right math materials and they receive positive messages about their potential ability" (p. 4). The second idea key point is from a different book that Boaler (2016) wrote *What's Math Got to Do with It?* Boaer (2016) states that:

> Most American math classes have them [students] sitting in rows and listening to a teacher demonstrate methods that students neither understand nor care about. Far too many students in American hate math and for many, it is a source of anxiety and fear.

As a future educator, I want to research the mindsets of elementary school students and see if there is a way to create a more positive outlook for students in math. I want to see if there is a way that teachers can make math more engaging for students so that they want to have careers that involve mathematics instead of being scared of the subject. There have been recent studies that have shown that of the fifty percent of students who attend two-year colleges, "about 70 percent of those students are placed in remedial math courses repeating math courses that they took in high school. Only one in ten of the students pass the course. The rest leave or fail." (Boaler, 2016, p. 4). Growth mindset, while it will benefit the students in school now, will also be something that can benefit them for the rest of their lives. The use of a growth mindset can change the way someone views problems in life. Having a growth mindset can benefit students now as well as in the long term "by helping them thrive on challenges and setbacks on their way to learning" (Dweck, 2015, para 5).

My primary research question is related to teachers and changing student's mindsets. How do teachers change elementary school students' mindsets about mathematics? My related or secondary research questions relate to teachers as well as looking into the students and their perspectives. What does research say about changing students' mindsets about mathematics? Why do students have a negative mentality about mathematics? How do teachers teach mathematics in the classroom? And what could teachers do to change the way they teach mathematics to change the mindsets of students? Are there resources for teachers who want to change the mindsets of students to engage more in mathematics? If there are, what are they?

Literature Review

Many teachers tell their students that it is okay to not be good at math. They tell them not everyone can be good at it so it's okay. That they just need to make it through high school and know the basics. Even so "Approximately 50 percent of students in the United States attend two-year colleges. About 70 percent of those students are placed into remedial math courses repeating the math they took in high school. Only one in ten of the students passes the course. The rest leave or fail" (Boaler, 2015, p. 4). Let's break that down into simpler numbers. Our pretend United States is going to have 100 people. Of those 100 people, 50 of them go to a two-year college. That seems like an okay average since we can assume that some students attend a 4 year and others attend vocational schools. Now 40 of those 50 people have to retake a math class they took in high school and only 4 of those 40 people pass the class. The other 36 people fail the class or drop out because it gets to be too difficult. Why is that? What happened? Most likely in elementary or middle school, they came across a teacher who told them they did not need to worry about doing well in math because not everyone can be good at it. This is not true. Everyone has a math brain. They just need to find the right person to explain it in the right way to them.

What is Mathematics?

Most people see mathematics as a set of rules or procedures that need to be followed to achieve an answer to a question. Kenschaft (1997) says that math is "the study of patterns and the use of patterns to solve problems" (Kenschaft, 1997, p. 5). Boaler (2015) also talks about math being a different language. When Boaler (2015) talks about the communicative approach to math she describes how students use different ways to talk about math, including "words, diagrams, tables, symbols, objects, and graphs" (Boaler, 2015, p. 59). While working with these different ways to

talk about math students would periodically be asked to explain what they were doing and their thinking behind it. Eventually, students looked at math as a different form of communication. According to Boaler's book, one student said "Math is kind of like a language, because it has got a bunch of different meanings to it, and I think it is communicating. When you know the solution to a problem, I mean that is kind of like communicating with your friends" (Boaler, 2015, p. 59). If we look at math in the sense of a form of communication or another language the idea behind it becomes slightly less terrifying. People learn new languages all the time.

What is Growth Mindset?

The Merriam-Webster online dictionary has two different definitions for the word mindset. The first is "a mental attitude or inclination" and the second is "a fixed state of mind" both of these definitions help contribute to the idea behind what a growth mindset is. Carol Dweck is the person that is thought of when educators think about growth mindset. It is her research that sparked the idea of needing to look at a students mindset correlated to the way they learn. Dweck (2015), says that mindset is "how they perceive their abilities" (para 2). There are two different types of mindset, fixed and growth, people with a fixed mindset believe that their intelligence is fixed or cannot grow. Those with a growth mindset believe that their intelligence can always be further developed. There are a few factors that need to be considered when looking at mindset. The first being, every person has both mindsets, second that it is a good thing, and third to have a growth mindset it is important to look at our fixed mindset thoughts. (Dweck, 2015). When students start struggling in school many parents encourage their children by saying things like ‘you are so smart' or ‘you gave it your best shot' these things limit mindset and actually encourage a fixed mindset in students. According to Hochanadel and Finamore (2015) sayings

like this "confirm the fixed mindset and makes kids all the more certain that they don't want to try something difficult" (Hochanadel, 2015, p. 49). Since Dweck's original research has been published many educators have started doing their own research on mindset and how it affects their students. Hundreds of lesson plans have been developed around the idea of teaching a growth mindset in classrooms and encouraging it at home.

Are Mathematical Mindsets a Problem?

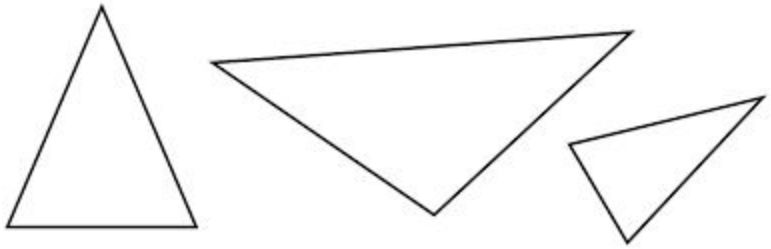
Boaler (2016) states in her book *Mathematical Mindsets* that the "single belief-- that math is a ‘gift' that some people have and others don't-- is responsible for much of the widespread failure in the world" (Boaler, 2016, p. xii). In a study conducted by Nelson (2016), he pulls data from the National Center for Education Statistics (NCES) that states "less than 40% of students are proficient in math" (Nelson, 2016, p. 184). When students are failing to put in the effort at school because they believe they do not have the ‘gift' of math, that causes problems for students and teachers. This means teachers are working twice as hard to improve students self-esteem and mindsets while also trying to teach them math. Mathematical mindsets are becoming a big problem in all of the education, by decreasing the number of students who are willing to take high education math classes and go into fields and careers that involve doing higher level math.

What are the Problems with Today’s Teaching?

There are a few different reasons that have been identified as to why students struggle with math and with their mindsets. One of the biggest problems is the attitudes that teachers, parents, and other role model figures have towards the subject of mathematics. "Very often it is the view that educators hold about the importance of mathematics in the classroom that affects the anxiety that students develop towards it" (Hatfield, 1997, p. 4). Many teachers believe that only certain

students can be good at math, based on whether or not they were born with the brain for it. In the book "*Multiplication is for White People" Raising Expectations for Other People's Children* written by Delpit (2012), she talks about how there is not an achievement gap at birth. As well as the idea that when we assume that some children are at a disadvantage because of who they are or where they live then "Our tendency is to teach less, to teach down, to teach for remediation" (Delpit, 2012, p. 6). While Delpit (2012) may be talking about children of color in her book this can also apply to all children.

There are three different things that teachers and students currently use that can affect a students mindset when learning mathematics. They include visual perception, Einstellung effect, and functional fixedness. (Allinger, 1982). Visual perception is when a teacher continuously shows the same example of something and then when the visual changes even slightly the students' perception of what they are seeing. (Allinger, 1982). For example, if a teacher always draws a triangle that looks like the first one on the left of the picture the student may become confused and not know what the shape is when showed the two triangles on the right side. The Einstellung Effect is when a student becomes so used to using a specific method that even though they learn an easier method for solving the same problem they continue to use the first method they learned. (Allinger, 1982).



One example of this is when students are taught how to add vertically. After that when given the same problem in a horizontal form they will take the extra step of re-writing the

problem in a vertical form before doing the addition. Functional fixedness is when a student uses something only for a fixed purpose that was given to it. (Allinger, 1982). For example, the letter ‘x' has many different uses is mathematics; however, if a student is introduced to the symbol used to indicate multiplication, they may struggle to understand the concept that it can also become a variable when moving into algebra. (Allinger, 1982). Another problem with current teaching is that there is too much content trying to be covered in each grade. Protheroe (2007) says that the curriculum is "a mile wide and an inch deep" (Protheroe, 2007, p. 51). There are five different categories of content standards that students learn each school year. They include numbers and operations, algebra, geometry, measurement, and probability and statistics. Each grade level has standards that relate to each of these categories in some way. The younger grades have simpler concepts that they learn that will help them with the more complex ones later.

What Should Teachers Know to Help Students Be Successful?

Something that many educators seem to be agreeing on is that teachers need a strong solid foundation in math to be able to help their students the best they possibly can. Ball (2005) says that "many U.S. teachers lack sound mathematical understanding and skill" (Ball, 2005, p. 14). In her study Ball looks at if teachers need to know common or specialized content knowledge. Her study was inconclusive on this front but it did determine that "knowing mathematics for teaching demands a kind of depth and detail that goes well beyond what is needed to carry out the algorithm reliably" (Ball, 2005, p. 22). There are two different models that are currently being explored to help teachers develop stronger foundations. The first is called Connections, Representations, and Misconceptions, or the CRM Framework. The second is the Mathematical Knowledge for Teaching Framework or the MKT Framework.

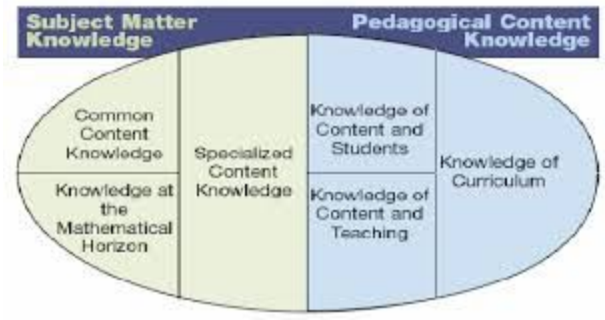
Connections, Representations, and Misconceptions

This Framework focuses on professional development for current teachers. Walker (2007) created this framework for two main reasons. The first being teachers having "inflexible attitudes about mathematics and its teaching" (Walker, 2007, p. 117). The second being that teachers lack a "deep understanding of basic mathematical concepts" (Walker, 2007, p. 117). During professional development seminars, teachers were initially provided with solving math problems together. Walker (2007) says that teachers became anxious, saying things like "This is too hard," "I forgot how to do this", "and "I was never good at math" (Walker, 2007, pg 119). These problems were connected to what they were teaching their students in the classroom at the time but the teachers still became anxious and unsure of themselves. Walker (2007) knew this was where they needed to start if they wanted to improve math instruction in the classroom. The first part was the connections. Teachers needed to be able to form connections between mathematical concepts, students knowledge, and procedural and conceptual knowledge. (Walker, 2007). The second part was the representations. Teachers needed to be able to use multiple representations of concepts, problems, and solutions so that students had multiple ways of trying to understand the patterns. (Walker, 2007).

The third part was the misconceptions. This was teachers needed to be able to see a student's misconceptions and be able to address the errors they were making. (Walker, 2007). These three steps were not going to be enough, they needed to find a way for teachers to be able to use them all together while also enjoying the math process. Walker (2007) created this by making the professional development sessions she held to be something that teachers could easily transfer into their classrooms. The lessons were fun and engaging while also being useful.

Mathematical Knowledge for Teaching

The MKT framework focuses on the things that teachers should know the be able to help teach their students. This framework focuses on multiple different domains that are usually presented in an oval. They are divided into subject matter knowledge (SMK) and pedagogical content knowledge (PCK). (Mosvold, 2013). The PCK side of the oval is represented in blue and the SMK side is represented in green. The SMK sided is focused on what the teacher knows. Common content knowledge is something that an average person would know. Knowledge at the mathematical horizon looks at what students will need to know in the future. Specialized content knowledge is what "allows teachers to engage in particular teaching tasks, including how to accurately represent mathematical ideas, provide mathematical explanations for common rules and procedures, and examine and understand unusual methods and problems" (Hill, 2008, p. 378). On the PCK side, it is focused on pedagogy. The knowledge content and students look at how students think about and learn mathematics. Knowledge of content and teaching combines the SMK with the design of instruction that the teacher uses. The knowledge of curriculum is the "particular grasp of the materials and programs that serve as 'tools of the trade' for teachers" (Shulman, 1987, p. 8). MKT also looks at the idea of lateral curriculum knowledge and vertical curriculum knowledge. Lateral is what a student learns in one school year, vertical is what the students will learn through their education. (Mosvold, 2013). This framework is supposed to help teachers be able to learn the different concepts as well as be able to understand misconceptions.



How Can Teachers Help?

In the book *Math Power: How to Help Your Child Love Math, Even if You Don't* written by Kenschaft (1997), she talks about how parents and teachers can help prevent math anxiety and make math fun at the same time. In the chapter focused on alternative approaches to education, she discusses three theories that were being looked at to implement reform on math education in the public school system. The first of these theories that connects with what has been stated so far is "The self-esteem or feel-good theory" (Kenschaft, 1997, p. 177) which focuses on "equity issues, noting that faltering student egos have been a major cause of low achievement" (Kenschaft, 1997, p. 177). This directly relates to the idea of growth mindset that Dweck (2015) and Hochanadel (2015) talk about in their articles. The idea that simply encouraging and praising effort does not equate to having a growth mindset, in fact, it can hinder the growth mindset.

Methods and Procedures

This capstone project is going to look at: How teachers can change elementary school students' mindsets about mathematics? To do this the researcher is going to conduct a 4-week research project in a classroom during which data will be collected through the use of an anonymous student quiz to determine if it is possible to change the mathematical mindset of students based on implementing certain strategies through teaching. The research will also be conducting interviews with teachers and a principal as well as implementing lesson plans in the classrooms of the interviewee's to see first hand what their students' mindsets are like when doing math.

Starting the semester I knew exactly what I wanted to do for my project. I had been collecting books and articles since the previous summer to be able to complete my research.

Before I was even enrolled in a capstone class I started reading a few of the books that I had collected to start my research and help me assess what kind of questions I really wanted to answer. It took a lot of time to narrow down my research since I found so many different aspects of it interesting, however, with the help of Dr. Thao I was able to create my primary and secondary research questions which gave me a place to start learning more from the research. In the end for my project I decided wanted to look at how mindset and mathematics go together and if students have a positive mindset will their math scores improve specifically at the elementary school level. To do this I did a few different things including research, creating lesson plans, and implementing lesson plans in classrooms at a local elementary school.

After my library research, the first thing I did for field research was go to a 4th/5th combo class at a local elementary school. I gave them a survey on mindset, one side was multiple choice asking about growth and fixed mindsets. The other side was a list of free response questions that asked about their mindsets in math. (See Appendix C). The purpose of this was to see what the students knew about growth mindset first and then to find out how they felt about math. The second thing that I did was teach a lesson on growth mindset so the students could gain a better understanding of what growth mindset actually is. (See Appendix E) The third thing I did was go into the same classroom that I gave the survey in and implemented a few different mindset strategies. To answer the questions previously stated, I will be conducting field research as well as online and book based research. The book and online based research will be reflected in a literature review in the final paper. My field research will be conducted at an elementary school in Monterey County. The research will consist of a pre-assessment and a post-assessment for the students, as well as an interview with the teacher. Between the pre- and post- assessments

(Appendices A, B, C, and D) I will be helping the teacher implement different methods and strategies to see if student mindsets can be changed. The online and book based research I will be doing will help guide the paper as well as the field research in directing me towards which standards are needed for each grade level, talking about what the different mindsets are and how they affect students in mathematics, as well as how the development of math over time has either hindered or improved mathematical mindsets. After working with the students and teacher for about a month and a half or so I will conduct a second interview with the teacher to find out if she saw any changes in her students that may support the post-assessment results I will be getting. I also would like to interview 3-4 other teachers (Appendix E) as well as the principal (Appendix F) at the school I am working at to see what they have to say about their students' mindsets about math. I believe talking to different teachers possibly at different schools will give broader perspectives to help determine how much of an issue in schools this is. I believe talking to the principal at the school I am doing most of my research at will give me an administrator perspective to add into the paper so that the final findings would be more beneficial to all educators and not only teachers.

My field research starts on February 5th in a classroom where the students will receive the pre-assessment. From February 7th through March 28th, I will be in the classroom on Tuesdays and Thursdays observing and helping the teacher prepare lessons and help implement new strategies for teaching math. On March 28th, the students will receive the post-assessment. On April 2nd I will meet with the teacher to discuss the results and interview her and see what differences she saw in her students. My goal in terms of research is to finish conducting research by March 8th and to then use that to create a more thoughtful annotated bibliography as well as

do some more in-depth library research having some more guiding questions as to what I will need more research on based on the books that I will have read. My other goals for the month of March include creating interview questions for teachers, finding 2-3 more teachers to interview, as well as setting up a meeting with the principal at the elementary school where my field research is taking place to ask her interview questions as well. I plan to have all interviews completed by the third week of March. All papers are due April 9th. I will continue to revise through the first week of May when the final capstone binder is due.

In the end, I will have a 15-page paper that evaluates why students have a negative view of mathematics, how it affects students, as well as how teachers can improve student's mindsets. This will be done through the anonymous survey given to students, teacher interviews, as well as extensive research on the topic.

The first mindset strategy that was implemented in the classroom was a traffic light strategy. The students were each given a red, yellow, and green card that was laminated with their name on it placed on a ring. The purpose of these rings was to allow students to reflect as well as for the teacher to be able to judge if students were understanding what was being taught. If a student placed the red piece of paper on top it meant that they were lost and needed help, yellow meant that they needed the teacher to slow down a little bit, and green meant they understood or that they were able to help others depending on what task was being done at that time. This strategy was found in the book *Mathematical Mindsets* written by Jo Boaler. To introduce the traffic lights I created a lesson plan based on two different math problems that required grouping and multiplication. Both types of skills the students had been introduced to

before. (See Appendix E). After going over these problems and explaining how to traffic lights worked the kids in this class used them for the next week or so.

After that, I introduced number talks. This had two purposes. The first being a technique to change mindset, the second was to help students increase their number sense. After a few weeks of using the traffic lights, conducting number talks, and working with the idea of growth mindset I once again gave the students the mindset survey, it was the same one that each student completed the first time. The teacher had each student write a number on the corner of their paper so that she could match them together and we could see results and if they changed as individuals as well as as-as a class. Since they used numbers there were anonymous to me as well as anyone besides the teacher that looks at them.

Another aspect that I wanted to explore was if mindset was a problem in only this class or if it was common across multiple classrooms. To do this I went into 3 other classrooms and taught a lesson in each class. These classes were slightly varied in grade level, one was a 5th-grade class, one was a 5th/6th combo, and one was a 6th-grade classroom. In each classroom, I taught a different lesson based on what the class was learning or needed to focus on at the time.

In the 5th grade class, I taught a lesson on divisibility rules (See Appendix G). The teacher asked for this because they had been working on division when the teacher realized they did not have the skills needed. They were struggling with multiplication and understanding multiples and the teacher believed that a lesson on the divisibility rules would be helpful for them. In the 5th/6th-grade combo class I taught a lesson on multiplying and dividing base ten exponents (See Appendix H). The teacher requested for a lesson like this the class because they were going to

start working with exponents and they believed that their students could use a review on how to multiply and divide by base ten exponents. Lastly, in the 6th-grade class I did an open-ended math problem with them (See Appendix I). The purpose of this was partially to see their mindsets as well as a practice for the SBAC performance test that they will take. Teaching these lessons allowed me to be able to compare the different classes and the mindsets they had while doing these activities. Each activity that was chosen had educational value but was also made to be engaging to the students.

There are many educators who would be interested in my final product. This could include all teachers, while my research focuses on K-6, it would be applicable to all K-12 teachers. It could also be of interest to administration, curriculum writers, parents, as well as future teachers. The final product will be accessible through the CSUMB library database. Administration could use this information to provide professional development training to current teachers. If teacher's know better tools to use to teach their students test scores could increase which would interest administration. Curriculum writers could use this information to help revise curriculum to implement new strategies that can help promote a growth mindset and better learning opportunities in students.

Results, Findings, and Discussion

At the beginning of the semester the researcher started by asking four different secondary questions. These included what does research say about changing students' mindsets about mathematics? Why do students have a negative mentality about mathematics? How do teachers teach mathematics in the classroom? What could teachers do to change the way they teach mathematics to create a more positive mindset? As well as, are there resources for teachers who

want to change the mindsets of students to engage more in mathematics? If there are, what are they?

The first question that the researcher posed was "*What does research say about changing students' mindsets about mathematics?"* To answer that question the researcher did a few different things. The first was library research, the second was taking that research and implementing it into a classroom at a local elementary school. This class is a fourth and fifth-grade combo class and will from this point forward be referred to as class A.

The first thing that the students in class A did was take a growth mindset survey. This allowed the researcher to see what the students knew about growth mindset as well as how they felt about the subject of mathematics. The students were given the presurvey at the beginning of February and the post-survey in the middle of April. This gave the researcher about 10 weeks to implement different lesson plans to try to change students mindsets.

Students in class A were introduced to the Light Reflection System after they completed the presurvey. Theoretically, this practice of placing the color light on the table they were feeling while doing independent work or working as a class would show the teacher how the students were doing without waiting until the assignment had been turned in or waiting for the end of the unit. The use of the traffic lights seems like a great idea in theory however, in practice, it was not as successful. One of the problems with this system was when the researcher tried to introduce it the system that it was the middle of the school year, the students already had set routines and trying to change those routines was confusing for them. A second problem with this system was the students were not always comfortable placing the color on the desk that actually represented how they were feeling about a subject. The researcher noticed that if one student put a green light

up the student next to them would also put a green light up even though they did not fully understand the concept that was being taught. The researcher only left the traffic light system in place for about a week after seeing that students were not responding well to it.

The second growth mindset strategy that the researcher implemented in class A was number talks. This was done to help students gain confidence in themselves as well as increase their number sense skills. Once again one of the problems with this strategy was it was implemented by the researcher in the middle of the year and the students already had set routines in place. Another problem with this strategy was the students were preparing for state testing so they had limited amounts of time to learn new things and they were doing a lot of reviewing of skills and concepts. The students did enjoy learning about number talks and how they worked and they did enjoy conducting them, however, they could have been more effective had they been introduced at the beginning of the school year instead of over halfway through the school year.

After ten weeks of using these different strategies, the teacher of class A and the researcher both saw differences in the students. The most effective tool that was used in this classroom over the ten weeks was simply introducing them to the idea of what growth mindset was. Teacher A stated during an interview that "they notice when others have a fixed mindset [the students] call them on it. Or they catch themselves." Both of the other strategies of number talks and the traffic light reflection could have been beneficial as research had stated if they had been introduced to the concepts earlier in the year before they had set routines.

The researcher analyzed the data between the pretest and the posttest that were given and the results were very inconsistent. The first question says *You can learn new things, but you*

can't get more intelligent. The data shows that between the pretest and the posttest that the number of students that were not sure decreased from 4 students down to 2 students. The students that agreed and strongly agreed decreased from 7 students to 3 students. Which leads to the students that strongly disagreed with the statement to increase from 9 students to 14 students. This shows that students changed their mindset from thinking they cannot get smarter to believe that they can get smarter.

The second question says *If your parents are not smart, you can't be smart.* The data shows that between the pretest and the posttest that the number of students that were not sure decreased from 3 students down to 1 student. The number of students who strongly disagreed with this statement stayed at 17 between the pretest and post-test. Two students indicated that they strongly agreed with this statement in the post-test that had either been not sure or strongly disagreed during the pretest.

The third question says *You can get more intelligent.* For this question, the data shows the number who strongly agree and agree during the pretest and posttest stayed the same respectively at 16 and 3. While one student went from not sure to strongly disagree from the pretest to the post-test.

The fourth question says *Through hard work, you can get smarter.* The data shows that during the pretest 11 students strongly agreed and 6 agreed with this statement while the post results show that changed to 16 strongly agreeing and 2 agreeing. The number of strongly disagreed stayed at two for both while the number of not sure decreased from 1 to 0.

The fifth question says *You are born with your level of intelligence and that won't change.* The data shows that 5 students were unsure at the beginning but that number went down to 4

during the post-test. The number of students that strongly disagreed went from 12 to 14 between the two tests. While the number of strongly agree also decreased from 3 down to 2. No students agreed with this statement on either test.

The sixth question says *No matter how much you try, you can't get smarter.* The data shows that during the pretest most students strongly disagreed with this statement, with 17 strongly disagreeing during the post-test this number dropped from 17 down to 15. The number of students increased from 1 not sure to 3 not sure students. However, the number of students that agreed or strongly agreed stayed at 2.

The seventh question says *If you have a hard life, you won't be successful*. The data shows that during the pretest 6 students were unsure and 12 strongly disagreed. While in the post-test those numbers went to 5 students being unsure and 15 strongly disagreeing. The number of strongly agree and agree dropped from 2 during the pretest to 0 during the post-test.

Lastly, the eighth question says *There is a limit on how intelligent you can get*. The data shows that 4 students went from unsure in the beginning to 6 being unsure during the post. The number of students that strongly disagreed and the number that strongly agreed stayed the same at 10 and 3 respectively. The students agreed during the pretest went from 3 down to only 1 in the post-test. The results of these tests, as stated before, are inconsistent. There are a few reasons the researcher came up with for why this may have occurred. The first being that this school that was used has a very high trauma rate which impacts the way that all the children learn, comprehend, and answer questions. The second reason is that this school has a high number of English Language Learners, many students parents only speak Spanish at home making learning English more difficult for the students. Lastly, the researcher realized that since the school has a

lot of ELL students and students that have experienced trauma, many students are far below grade level, which means that while the researcher was in a fourth and fifth-grade combo class a lot of the students were reading at a third or below grade level.

The second question that the researcher posed was "*Why do students have a negative mentality about mathematics?*" To answer this question the researcher interviewed 4 teachers (See Appendix A), they will be known as teacher A, teacher B, teacher C, and teacher D, as well as the principal of a school (See Appendix B). The researcher also gave anonymous mindset surveys to class A (see Appendix C). Question number four that the teachers were asked was Why do you think students have a negative mindset regarding math? All four teachers gave answers that were very different however teacher A and teacher B agreed that one reason students have a negative mindset is that they are not provided with enough support. Teacher C and Teacher D had similar responses but they also talked about how hard math is and that when students get stuck on something hard they tend to give up rather than push through the toughness of the problem. Which leads to the interview with the principal, they were asked do you think mindset is a problem in your school? To which they responded with "once something becomes challenging the students often won't push through that challenge. They will stop right there" (Appendix B). When you combined the two main things that these teachers and principal talked about, lack of support and not willing to push through, it is clear that students will struggle with math. The researcher also asked the teachers if they thought that mindset impacted how students learn math, all four teachers answered the same thing, that yes, mindset can impact how students learn.

The third question that the researcher posed was *"How do teachers teach mathematics in the classroom?"* As well as what could teachers do to change the way they teach mathematics to create a more positive mindset? To answer this question the researcher once again interviewed teachers and a principal. This time asking the teachers what do they do to change students mindsets in math? Or to actively keep students from having a negative mindset. Each teacher had a different response. Teacher A says they incorporated more math games into their curriculum as well as they slowed down and made sure that concepts were fully understood before moving on. Teacher A also says that they incorporate review, games, and new content altogether to keep children engaged and actively participating. Teacher B says they address their students frustrations as well as let them know that it is okay to not understand yet but with some practice, they will get better. Teacher B also says that they try to make math fun and exciting by using different approaches to math. These approaches were not elaborated on. Teacher C takes a completely different approach with their students. Teacher C empathizes with their students, and then shows them real-world examples of why math is important this teacher also tells their students that behavior is up to them and only them and they praise hard work and they celebrate effort. The fourth teacher, teacher D, says that they find the little strengths that their students have and make that a priority to help build on learning new skills. They also create a safe atmosphere where the students know it is okay to not always be right as long as you are trying. Since all four teachers believed that mindset was a problem in their classrooms when interviewing the principal the researcher asked if they had a way that they were supporting their teachers in math. The short answer is no they do not. However, next year they will be using a

grant given to the school to provide some form of math support for teachers and students but it is unclear of what that will look like.

The fourth question that the researcher posed was *"Are there resources for teachers who want to change the mindsets of students to engage more in mathematics?"* If there are, what are they? This question was a bit tougher to answer using only one school in the area as a sample school, however, the teachers and researcher did their best. Most of the teachers said that they were not receiving much in classroom support for mathematics. Through literature research, the researcher found that there are resources available but most of the time teachers would need to be finding during their time outside of the classroom to be able to prepare it and implement some of the strategies in their classrooms. The most helpful resource that the researcher found was the book *Mathematical Mindsets* written by Boaler. This book had many different strategies and resource ideas for teachers to improve mindset in classrooms while also encouraging math learning.

Recommendation

Based on the research that was done and the data that was collected at a local elementary school, the researcher would recommend that teachers start out the school year with strong mindset strategies. These can include number talks as well as reflection tools like the traffic light system. One of the things that the research found worked best was just talking about what growth mindset is, as seen through the results presented earlier from class A, once students knew what growth mindset was there were more likely to display a growth mindset and encourage their peers to show a growth mindset as well.

Problems and Limitations

There were a few minor problems that the researcher ran into when conducting research that may have affected the data that was collected. During the library research phase, the researcher struggled to find sources that were both about growth mindset as well as elementary school mathematics. A lot of the research that was found was about middle school and high school level mathematics. The first problem the researcher encountered while conducting field research was that they were trying to introduce new routines over halfway into the school year. This was met with resistance by the students. The second problem that the researcher encountered while conducting field research was that since it was only a few weeks before state testing the classes were doing a lot of review rather than learning new content which made it hard to find time to implement new strategies since they were doing very specific content review based on curriculum provided to teachers by administration.

Conclusion

From my research, negative mathematical mindsets are a problem in the classrooms at the school in Monterey County where I did my field research. Library research also shows that negative mathematical mindsets are a problem in classrooms around the country. There are a few different ways to help teachers and students improve mathematical mindsets. The first starts with the teacher. The teacher needs to be positive when teaching math to their students. The second is that students need to be educated about what growth and fixed mindsets are so they know that learning is for everyone and not just for some people.

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Appendices

Appendix A: Teacher Interviews

Appendix B: Principal Interview

Appendix C: Growth Mindset Pre-Quiz

Appendix D: Growth Mindset Post-Quiz

Appendix E: Growth Mindset Graphs

Appendix F: Growth Mindset Lesson Plan

Appendix G: Number Talk Lesson Plan

Appendix H: Divisibility Rules Lesson Plan

Appendix I: Exponent Lesson Plan

Appendix J: Open Ended Math Problem Lesson Plan

Appendix A

Teacher Interview Questions

Teacher A

1. **Do you think students mindset can impact how they learn math?**

Yes, students often come to math and science with a mindset that it is hard and/or they can do do math/science.

2. **Do you think your students mindset regarding math is a problem? In your classroom? In this school?**

Yes it was at the beginning of the year. By integrating in games and slowing down so that they grasp a concept before moving on, their mindsets have been changing. At this school, I have noticed more of a problem than at another school were I taught. There were still students with a fixed mindset, but this school seems to have more students with a fixed mindset.

3. **What do you do the change it? Or What do you do actively do to keep students from having a negative mindset?**

Games, slowing down, teaching a concept in many ways, have groups work together, partners, students come to the board to do problems (they love this), mix up math between review, math minutes, games and new concepts.

4. **Why do you think students have a negative mindset regarding math?**

I am guessing here, but perhaps teachers going to fast to try to cover all standards without student understanding. I believe in less is more. If they understand 5 concepts and we do not cover 3, then at least they have confidence that they can learn the others. I have also noticed at this school students want to play Prodigy a lot. It is fine on occasion, but I do not feel it is good at teaching for understanding.

5. **Have you heard of number talks before?**

Yes

6. **Have you/would you consider using them in your classroom?**

Yes. I think it have done it before, just didn't have a name for them.

Teacher Interview Questions

Teacher B

1. Do you think students mindset can impact how they learn math?

I definitely think that students' mindset can impact how they learn math, because they see it as a process. New concepts may be challenging at first, but my students understand that they can grow in math through practice.

2. Do you think your students mindset regarding math is a problem? In your classroom? In this school?

No, my students enjoy math. It is a subject they look forward to, because they are confident in it and enjoy the learning strategies used in math. We use a lot of math talk and kinesthetic activities in math.

3. What do you do the change it? Or What do you do actively do to keep students from having a negative mindset?

I address their frustration by saying, "I sense that you may be frustrated." Then I tell them I know you don't understand it yet, but you will with practice. We then review what they might be missing as they tackle a math problem individually, in a small group, as a whole group, or with peers. I also try to keep math fun and exciting by doing a variety of different approaches to math. We also have math routines like starting the math lesson with warm-ups and sometimes exit tickets.

4. Why do you think students have a negative mindset regarding math?

I think some students may have a negative mindset regarding math, because they might not have been supported in it. They might not have seen math from an engaging perspective.

5. Have you heard of number talks before?

No, I have never heard of number talks.

6. Have you/would you consider using them in your classroom?

Teacher Interview Questions

Teacher C:

1. Do you think students mindset can impact how they learn math?

Yes I have found through 12 years of active teaching math that how students view learning and how they view their willingness to give effort to learn affects their acquisition of knowledge. Student who believe they can learn are more willing to try. Students who know that learning is important are more than likely going to be willing to work hard.

2. Do you think your students mindset regarding math is a problem? In your classroom? In this school?

Students who are below grade level with their basic math skill are more than likely not going to be engaged and work hard on grade level assignments. As a 6th grade teacher I have observed that students who know their multiplication are more willing to stretch their thinking powers and apply themselves at school. Conversely, students who have gaps in their basic foundational skills are reluctant to work in class. These concerns are ongoing in my classroom. Student skill sets are very diverse and on average this year is very low academically. Average reading scores in 6th grade are lower 3rd grade reading skills. This translates into ongoing struggles in math class due to the required reading necessary for common core math thinking. Students at this school do not have consistent at home support and this is an ongoing concern. Word problems as well as work that has more than one step are a consistent struggle. Also a point of reference is that as a classroom we know we can learn from our mistakes and therefore we must be willing to produce work.

3. What do you do the change it? Or What do you do actively do to keep students from having a negative mindset?

I tell students about my own struggle learning how to read as well as my being held back in Kindergarten. I explain to them what types of jobs my friends have and clearly relate that to the amount of leaning my associates were willing to complete. I show them pay scales for different jobs so that they see the connection between higher level learning and higher pay wages. I am honest with the students that they are a product of the behavior patterns they exhibit and it is up to them to be willing to try to learn. I value effort in my classroom and that is one way that I have combated negative mindset. I praise hard work and celebrate effort.

4. Why do you think students have a negative mindset regarding math?

When things are hard for people we tend to view them with a negative view of thinking. If you do not understand that fractions are parts of a whole and you do not know your addition and

subtraction strategies it is understandable why a student would view math negatively. Students who were unable or unwilling to learn their multiplication and division skills are going to struggle every day in math class and this will increase a negative view of math. Learning requires sustained and consistent attention to effort and if a student is consistently absent then the student may have a negative attitude towards learning by working.

5. Have you heard of number talks before?

No, I am unfamiliar with this idea.

6. Have you/would you consider using them in your classroom?

Yes, I am willing to try engagement strategies.

Teacher Interview Questions

Teacher D:

1. **Do you think students mindset can impact how they learn math?**

Definitely I have seen a lot of kids over the years that have had a bad experience in a previous class in math maybe they've just been plugged in and left to their own motivation or lack of motivation to do math a lot of girls seem to have an aversion to math when they enter 4th and 5th grade because they had a bad experience with math and say they are bad at it so yes i think a students mindset can impact how they learn math.

2. **Do you think your students mindset regarding math is a problem? In your classroom? In this school?**

In my classroom i try really really hard to build on little strengths whatever they may be say its even something far below grade level or maybe its just even their handwriting. Ill say your handwriting looks better than mine and they sit up a little straighter and their self-esteem and then i let kids know that if they had a bad experience in the past that we're a team and that whenever they hit a wall or have a question i want to be there that we're a team, i want to be there right next to them.

3. **What do you do the change it? Or What do you do actively do to keep students from having a negative mindset?**

Lots of one on one and i again like i said earlier find the little strengths and focus on that and i don't try to blow kids out of the water with overwhelming reminders about how far below grade level they may be. Some kids can handle a little bigger reminder or bigger hammer because they are tougher and some kids are a little more frail and fragile. I guess the big one is getting to know kids and they trust me and i go outside and i play with them at recess and i am playful in class. In general kids see my classroom as a safe family like atmosphere and uh i think setting up that first or side by side with lessons that you do in class that kids look forward to being here and we have a blast, the whole day is just a hoot and then when it comes time to deal with someone like my buddy [name deleted for privacy] who has really low math skills and hardly any self esteem regarding math then you can kind of build on where she is coming from in a fun and positive way rather than beating her over the head however she still doesn't know her multiplication tables and refuses to work on them so i do regularly let her know not necessarily verbally but with little quizens and stuff and little checks and informal assessments on the side and just kind of so she has regular reminders that she needs to learn them and hopefully she will own that. I can't force her to do it.

4. **Why do you think students have a negative mindset regarding math?**

Math is hard and kids like we were talking about this the other day they uh this generation and uh for the last 20 years or so kids would call it nuke it. Kids want to put everything in the microwave and if they can't learn it in one minute and 11 seconds then they don’t want to do it. They want to nuke everything. But math requires a large body of a base basic math fluency, number sense, adding and subtracting across tens and applying what you learned there to hundreds and the inverse operations all the little keys that unlock you know we always say we have a little mantra in here is math is logical, predictable, and it makes sense it's never really random so i dont think kids if they have a negative mindset about math its because they haven't been shown those keys before or it didn’t sink in i think i work really really hard to make math fun and but show them those little short cuts

5. **Have you heard of number talks before?**

No. *Researcher explains number talk* Okay we have done that before it was like a part of a regular thing mental math time. My kids come to the floor in front of the white board and i put a problem up and then they put their fist on their chest and then when they think they know one way to do it they put a thumb up and then when they have figured out another way to do it they put a finger up, we call that their gun, and then uh then then say alright fists down and have some kid come up to the board and says i did it like this in my head and then some other kid says well i did it differently so we have all these different visual examples of kids and what was going on with their thinking and then we talk about that and how it all works or sometimes it doesn’t work but someone thought it worked but at least they tried.

6. **Have you/would you consider using them in your classroom?**

See question above.

Appendix B

Principal Interview Questions

Principal A

1. **How do you think your students do overall in math?**

So I know that our students perform Below grade level in math as a whole.
I believe we only have 20 percent of our students at grade level according to cassp.
That's grades three to five. The data in K through 2 is not. It is only assessed on
District interims. We do better at district interims where on the last one I'd say about 40 percent K 3 were at grade level and then. Going by cassp About 20 percent and the upper grades. So math is a Period of struggle.

2. **Do you think a student's mindset can impact how they learn math?**

Yes because if they look at a problem overwhelmed by it their minds Simply shut off and then won't be able to proceed. So when I was a teacher I used to tell the kids we used to call them math puzzles not math problems and so it's just a puzzle. To solve it. So having that mindset that it's not a problem or a challenge or a puzzle or whatever you want to call them instantly turned. That switch for them. because calling it a problem you're like a problem how am i going to solve that so the mindset has a lot do with it
Yeah I feel like it's just a puzzle we can solve it.

3. **Do you think that mindset is a problem in your school.**

I don't know that mindset necessarily is a problem. I think that the problem is. Well I guess it is because what I see happen is that. Once. Something becomes challenging the students often won't push through that challenge. They'll stop right there. So that was a yes. Mindset is a problem. And it's that mindset of not I can or can't do this with that mindset of I have to struggle a little harder with this and work a little harder to get through it. So just that mindset of. Pushing through something that's difficult rather than the mindset of I can't do it.

4. **Do you have any specific ways that you're supporting your teachers in math?**

So in we have software that teachers can use but in grade the teachers that are my instructional leadership team have done achievement team methods and math where they've really honed in on. Standards and data and The Hadley methods of teaching they've done the whole achievement team which is a form of data teams. But it really hones in on the strategies that are used to making sure the strategies are effective and the data. So we've begun that at the At that level. Next year we're going to push through a bit of grade levels but that's that's really right now

the focus has been on our new language arts curriculum and not so much in math this year except for at the ILT level

5. **Do you think the attitude of the teacher makes a difference?**

Well attitude of everybody always makes a difference in everything we do. But I know that the teachers who took part in the ILT and really looked at it a little bit differently have different attitude when they re-taught it. And they had really really good results. So that attitude also that the students. Aren't at grade level yet but knowing where they are and how to bridge that gap. Has made I've seen that make a difference for several of the teachers this year where they especially in the upper grade where it's frustrating because the gap is wide that. That ability and that like OK I know where they are. I just have to take them up. Helped a little bit with the attitude and that made the instruction better too.

6. **Have you seen any teachers using strategies that have helped change students mindsets in the classroom?**

Yes I've seen teachers using more. Yes. So strategies to deal with rigor strategies with how to. Really. Solve. Math problems as opposed to just not being able to do with the one way so that that more supportive way of teaching of using we've kind of told them look at it like close Reading math is really close to reading radio lingo for very specific information. So I've seen that strategy of how to how to take apart a problem. I've seen teachers use different kinds of methods so kids can find something that works for them and then I've seen them differentiating so all of those Helped change students minds that it was known as different ways. There's no right way. To really get a problem. You. Know

7. **Do you have math intervention at your school?**

So this year we don't really have anything other than what the teachers are using we don't have a specific intervention problem there is there is a grant per ten thousand dollars for extra support and math that we'll be using next year and that'll go towards we're not quite sure how we're going to use it whether we'll use it for after school tutoring or is bringing somebody from outside to help. We haven't made that decision yet. So this year we haven't had strategic math intervention we've really focused on Rolling out new language arts curriculum only energy has been there. But. Math intervention helps if it's like reading intervention very strategic and targeted and not just as General has to be really study space. So We'll be doing that next year and it can't hurt.

Appendix C

Growth Mindset Pre-Quiz

Read the statements carefully, then choose the answer that best fits your opinion.

1. You can learn new things, but you can't get more intelligent.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure
2. If your parents are not smart, you can't be smart.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure
3. You can get more intelligent.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure
4. Through hard work, you can get smarter.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure
5. You are born with your level of intelligence and that won't change.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure
6. No matter how much you try, you can't get smarter.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure
7. If you have a hard life, you won't be successful.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure
8. There is a limit on how intelligent you can get.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure

What is a Mindset? Pre-Quiz

1. Do you know what growth and fixed mindsets are?

2. How do you feel about math?

3. How do you feel when you make a mistake in math?

4. How do you feel when something is hard for you in math?

5. What do you like most about math?

Appendix D

Growth Mindset Post-Quiz

Read the statements carefully, then choose the answer that best fits your opinion.

1. You can learn new things, but you can't get more intelligent.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure
2. If your parents are not smart, you can't be smart.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure
3. You can get more intelligent.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure
4. Through hard work, you can get smarter.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure
5. You are born with your level of intelligence and that won't change.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure
6. No matter how much you try, you can't get smarter.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure
7. If you have a hard life, you won't be successful.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure
8. There is a limit on how intelligent you can get.
    a. Strongly agree
    b. Agree
    c. Strongly Disagree
    d. Not sure

What is a Mindset? Post-Quiz

1. Do you know what growth and fixed mindsets are?

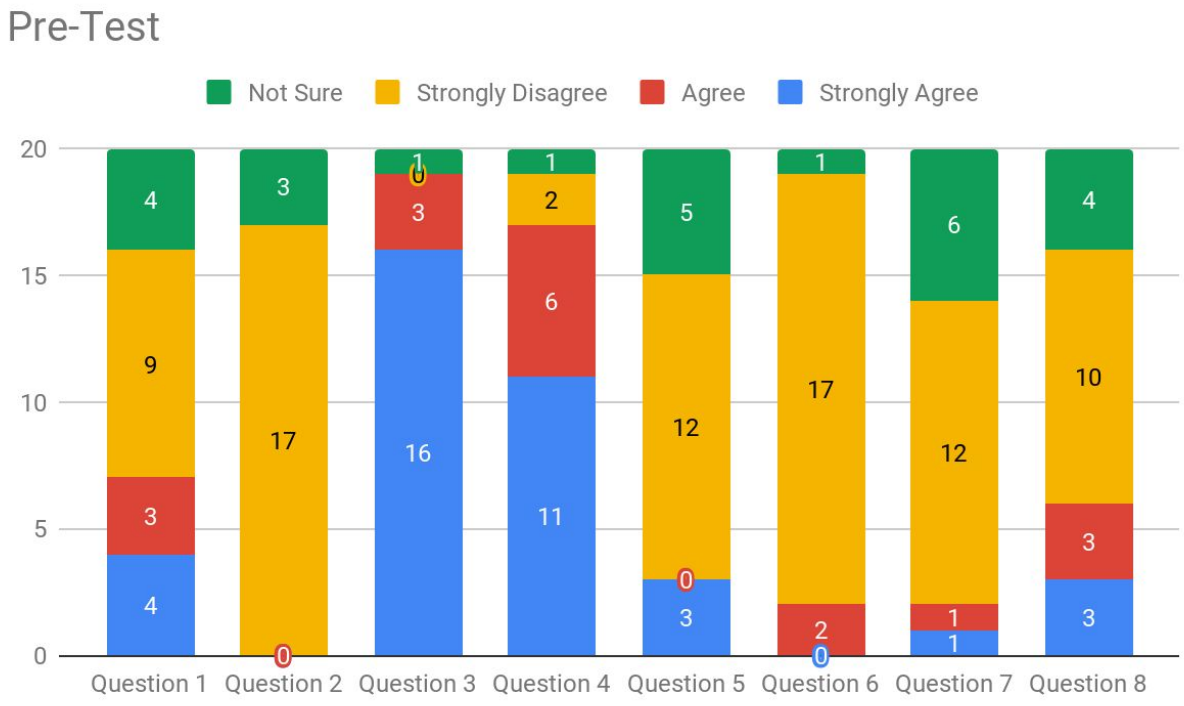
2. How do you feel about math?

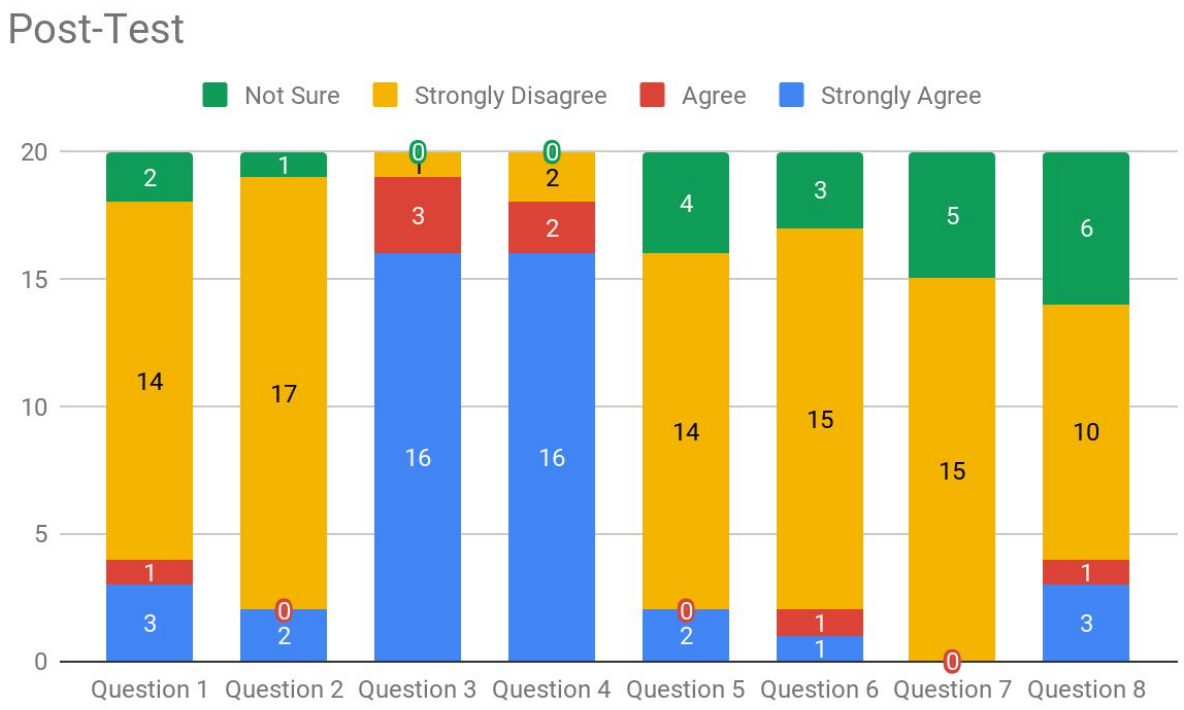
3. How do you feel when you make a mistake in math?

4. How do you feel when something is hard for you in math?

5. What do you like most about math?

Appendix E


Pre-Test
Not Sure
Strongly Disagree
Agree
Strongly Agree
20
15
10
5
0
Question 1
Question 2
Question 3
Question 4
Question 5
Question 6
Question 7
Question 8


Post-Test
Not Sure
Strongly Disagree
Agree
Strongly Agree
20
15
10
5
0
Question 1
Question 2
Question 3
Question 4
Question 5
Question 6
Question 7
Question 8

Appendix F

Growth Mindset

Lesson Plan for Grade 4-6
Duration: 70 minutes
Prepared by Marissa Bartelt

OVERVIEW & PURPOSE

Understand the difference between Growth and Fixed Mindset

OBJECTIVES

1. Show that intelligence is not fixed
2. The brain can grow

MATERIALS NEEDED

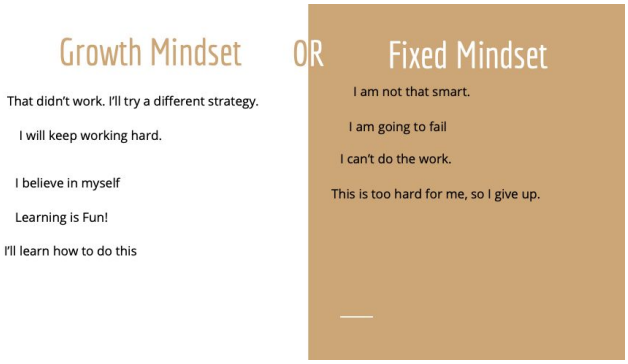
- Worksheets
- Pencils
- Projector
- Growth Vs Fixed Mindset

ACTIVITY

Ask the class if they know what a growth mindset is. Ask about fixed mindset.

Watch video on growth and fixed mindset
https://www.youtube.com/watch?v=2zrtHt3bBmQ

Talk about the video and who showed a growth mindset and who showed a fixed mindset



Complete the activity from the powerpoint that sorts sayings into growth vs fixed (the phrases start out jumbled and they sort them)

Apply to math using dog biscuit activity
Give students 4 minutes to work on their own 8 minutes to work with a partner. Go over as a class, ask for volunteers to show what they did.

Introduce Red, Yellow, Green light cards
Student place red card on desk if they need the teacher to stop and review
Student place yellow card on desk if they need the teacher to slow down

Student place green card on desk if they understand and can help others

If time:

- Apply light cards to brownie problem give students 6 minutes to work alone and then use cards.
- Read book on growth mindset
    - The Dot
    - Your Fantastic Elastic Brain: Stretch it, Shape it

Dog Biscuit Problem

How many ways can you make two groups of 24 dog biscuits?

How many ways can you equally group 24 dog biscuits?

Show your answer with pictures that shows all the ways.

Brownie Problem

Sam has made a pan of brownies that he wants to cut into 24 equal pieces. He wants to share them equally with 5 of his friends. How many brownies will each friend get? Draw a picture and color the brownies each friend will get a different color.

Appendix G

Overview Number Talks:

Goal:

Create an anchor chart with different methods of solving each type of problem. Try to add a new strategy to the chart each day.

Day 1

Introduce number talks: use kinder lesson and set expectations.

3/7

Day 2-6

Addition:

3/8, 3/11, 3/13, 3/14, 3/15

Day 7-10

Subtraction:

3/19, 3/20, 3/21, 3/22

Day 11-15

Multiplication:

3/25, 3/26, 3/27, 3/28, 3/29

Day 16-20

Division:

4/1, 4/2, 4/3, 4/4, 4/5

Number Talk Day 1

Lesson Plan for Grade 4/5, Math
Duration: 10 minutes
Prepared by Marissa Bartelt

OVERVIEW & PURPOSE

To learn how to conduct a number talk

EDUCATION STANDARDS

1. Operations and Algebraic Thinking

OBJECTIVES

1. Learn number talk procedures
2. Gain a better understanding of numbers
3. See the different ways that we can count numbers

MATERIALS NEEDED

- Students
- Whiteboard and marker --or-- anchor chart paper and pens.

ACTIVITY

Students gather around the whiteboard or anchor chart. (Wherever the number talk will take place)
Set 'norms' for number talk.
Give the students problem. For the first day it will consist of strings of dots taken from the book "Number Talks Whole Number Computation"
Give students appropriate amount of time to think about how to count the numbers
After adequate time has been given, as for answers. Write down all the answers that are given. Then ask for justifications "how you came up with that answer"

Number Talk Day 2-6

Lesson Plan for Grade 4/5, Math
Duration: 10 minutes
Prepared by Marissa Bartelt

OVERVIEW & PURPOSE

To learn strategies for addition

EDUCATION STANDARDS

1. Operations and Algebraic Thinking
2. Numbers and Operations in Base 10

OBJECTIVES

1. Practice number talk procedures
2. Gain a better understanding of numbers
3. See the different ways that we can add numbers

MATERIALS NEEDED

- Students
- Whiteboard and marker

ACTIVITY

Students gather around the whiteboard or anchor chart. (Wherever the number talk will take place)
Quickly review norms
Give the students problem. Day 2-6 will be addition problems from 2nd, 3rd, 4th, and 5th grade taken from the book “Number Talks Whole Number Computation”
Give students appropriate amount of time to think about how to count the numbers
After adequate time has been given, as for answers. Write down all the answers that are given. Then ask for justifications “how you came up with that answer”
Add to Anchor Chart any new strategies

Number Talk Day 7-10

Lesson Plan for Grade 4/5, Math
Duration: 10 minutes
Prepared by Marissa Bartelt

OVERVIEW & PURPOSE

To learn strategies for addition

EDUCATION STANDARDS

1. Operations and Algebraic Thinking
2. Numbers and Operations in Base 10

OBJECTIVES

1. Practice number talk procedures
2. Gain a better understanding of numbers
3. See the different ways that we can subtract numbers

MATERIALS NEEDED

- Students
- Whiteboard and marker

ACTIVITY

Students gather around the whiteboard or anchor chart. (Wherever the number talk will take place)
Quickly review norms
Give the students problem. Day 7-10 will be subtraction problems from 2nd, 3rd, 4th, and 5th grade taken from the book “Number Talks Whole Number Computation”
Give students appropriate amount of time to think about how to count the numbers
After adequate time has been given, as for answers. Write down all the answers that are given. Then ask for justifications “how you came up with that answer”
Add to Anchor Chart any new strategies

Number Talk Day 11-15

Lesson Plan for Grade 4/5, Math
Duration: 10 minutes
Prepared by Marissa Bartelt

OVERVIEW & PURPOSE

To learn strategies for addition

EDUCATION STANDARDS

1. Operations and Algebraic Thinking
2. Numbers and Operations in Base 10

OBJECTIVES

1. Practice number talk procedures
2. Gain a better understanding of numbers
3. See the different ways that we can add numbers

MATERIALS NEEDED

- Students
- Whiteboard and marker

ACTIVITY

Students gather around the whiteboard or anchor chart. (Wherever the number talk will take place)
Quickly review norms
Give the students problem. Day 11-15 will be addition problems from 2nd, 3rd, 4th, and 5th grade (taken from the book “Number Talks Whole Number Computation”
Give students appropriate amount of time to think about how to count the numbers
After adequate time has been given, as for answers. Write down all the answers that are given. Then ask for justifications “how you came up with that answer”
Add to Anchor Chart any new strategies

Number Talk Day 16-20

Lesson Plan for Grade 4/5, Math
Duration: 10 minutes
Prepared by Marissa Bartelt

OVERVIEW & PURPOSE

To learn strategies for division

EDUCATION STANDARDS

1. Operations and Algebraic Thinking
2. Numbers and Operations in Base 10

OBJECTIVES

1. Practice number talk procedures
2. Gain a better understanding of numbers
3. See the different ways that we can divide numbers

MATERIALS NEEDED

- Students
- Whiteboard and marker

ACTIVITY

Students gather around the whiteboard or anchor chart. (Wherever the number talk will take place)
Quickly review norms
Give the students problem. Day 16-20 will be addition problems from 2nd, 3rd, 4th, and 5th grade (taken from the book “Number Talks Whole Number Computation”
Give students appropriate amount of time to think about how to count the numbers
After adequate time has been given, as for answers. Write down all the answers that are given. Then ask for justifications “how you came up with that answer”
Add to Anchor Chart any new strategies

Appendix H

Divisibility Rules

Lesson Plan for Grade 5, Math
Duration: 120 minutes
Prepared by Marissa Bartelt

OVERVIEW & PURPOSE

Find patterns in a number chart to help learn divisibility rules

EDUCATION STANDARDS

CCSS.MATH.CONTENT.5.OA.B.3

CCSS.MATH.CONTENT.4.OA.B.4

CCSS.MATH.CONTENT.4.OA.C.5

OBJECTIVES

1. Analyze Patterns and Relationships
2. Gain familiarity with factors and multiples
3. Generate and analyze patterns

MATERIALS NEEDED

- Worksheets
- Pencils
- Markers, crayons, or colored pencils
- Divisibility Rules Powerpoint that follows Appendix A

ACTIVITY

Talk about what Divisibility is
- Must be divided evenly (has no remainders)

Talk about Prime and Composite numbers
- Prime: can only be divided by the number 1 and itself
- Composite: divisible by more than 1 and itself

Using the first 100's chart color, outline, or circle numbers. Answer the questions after each step.

1. Color in the multiples of 2 yellow
    - What pattern do you notice when you colored in the 2's?
    - Can we create a rule to know if a number is divisible by 2's?
2. Outline the multiples of 3 in red

    - What pattern do you notice when you outlined the 3's?
    - Can we create a rule to know if a number is divisible by 3's?
3. Circle the multiples of 6.
    - What pattern do you notice when you circled the 6's?
    - Can we create a rule to know if a number is divisible by 6's?

Using the second 100's chart color and outline numbers. Answer the questions after each step.

1. Color in the multiples of 5 in blue
    - What pattern do you notice when you colored in the 5's?
    - Can we create a rule to know if a number is divisible by 5's?
2. Outline the multiples of 10 in green
    - What pattern do you notice when you outlined the 10's?
    - Can we create a rule to know if a number is divisible by 10's?

Using the third 100's chart color and outline numbers. Answer the questions after each step.

1. Outline the multiples of 9 in purple
    - What pattern do you notice when you outlined the 9's?
    - Can we create a rule to know if a number is divisible by 9's?
2. Color in the multiples of 4 in pink
    - What pattern do you notice when you colored in the 4's?
    - Can we create a rule to know if a number is divisible by 4's?

Divisibility Rules Wheel

1. Fill in the rules

Divisibility Rules Practice worksheet

Color in Divisibility Wheel if time.

Discovering Divisibility Rules for 2, 3, & 6

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Color the multiples of 2 in yellow.

What patterns do you notice? _____

What rule can we write to know if a number is divisible by 2? _____

_____

Outline the multiples of 3 in red.

What patterns do you notice? _____

What rule can we write to know if a number is divisible by 3? _____

_____

Circle the multiples of 6.

What patterns do you notice? _____

What rule can we write to know if a number is divisible by 3? _____

_____

Discovering Divisibility Rules for 5 & 10

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Color the multiples of 5 in blue.

What patterns do you notice? _____

What rule can we write to know if a number is divisible by 5? _____

_____

Outline the multiples of 10 in green.

What patterns do you notice? _____

What rule can we write to know if a number is divisible by 10? _____

_____

Discovering Divisibility Rules for 4 & 9

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Outline the multiples of 9 in purple.

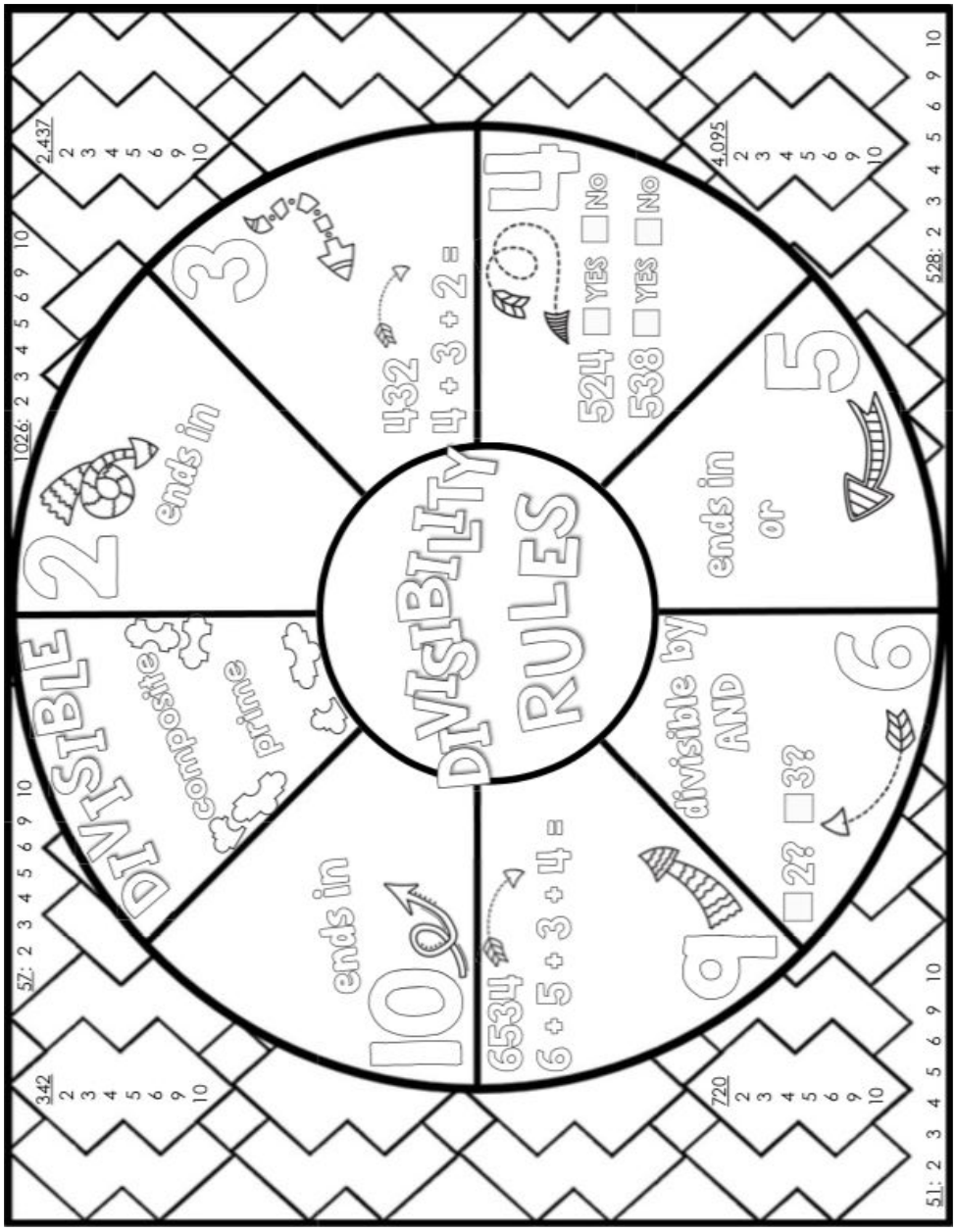
What patterns do you notice? _____

What rule can we write to know if a number is divisible by 9? _____

_____**Color the multiples of 4 in pink.**

What patterns do you notice? _____

What rule can we write to know if a number is divisible by 4? _____


DIVISIBLE
DIVISIBILITY RULES
2
ends in
3
4
ends in
5
ends in
or
6
divisible by
AND
ends in
10
prime
composite
57: 2 3 4 5 6 9 10
1026: 2 3 4 5 6 9 10
528: 2 3 4 5 6 9 10
51: 2 3 4 5 6 9 10
342
2,437
4,095
720
524 YES No
538 YES No
432
4 + 3 + 2 =
6534
6 + 5 + 3 + 4 =
2? 3?

Practice: Divisibility Rules

Write 2, 3, 5, 6, 9, or 10 for each divisibility rule below.

1. If a number ends in an even number (0, 2, 4, 6, 8), it is divisible by _____

2. If the sum (total) of the digits of a number is divisible by 9, then the number is divisible by _____.

3. If a number is divisible by 2 and 3, the number is divisible by _____.

4. If the sum (total) of the digits of a number is divisible by 3, then the number is divisible by _____.

5. If a number ends in zero, it is divisible by _____.

6. If a number ends in five or zero, it is divisible by _____.

Use the divisibility rules to answer the following questions. Answer YES or NO:

7. Is the number 342 divisible by 9? _____

8. Is the number 121 divisible by 5? _____

9. Is the number 340 divisible by 10? _____

10. Is the number 2,437 divisible by 2? _____

11. Is the number 4032 divisible by 4? _____

12. Is the number 411 divisible by 3? _____

13. Is the number 522 divisible by 6? _____

Write P for prime or C for composite to describe each number below:

14. The number 5 is _____. 15. The number 6 is _____.

Appendix I

Exponent Lesson Plan

Lesson Plan for Grade 5/6
Duration: 70 minutes
Prepared by Marissa Bartelt

OVERVIEW & PURPOSE

Discover what happens when you multiply and divide by exponents with base 10.

EDUCATION STANDARDS

CCSS.MATH.CONTENT.5.NBT.A.2

OBJECTIVES

1. Multiply and Divide with base 10 exponents
2. Order numbers from least to greatest

MATERIALS NEEDED

- Worksheets
- Pencils

ACTIVITY

As a class or in small groups work through number one on the distances from the sun worksheet.

Talk about how to tell which numbers are bigger and which ones are smaller

Have students order the planets and then go over them as a class.

Have students work on the multiplying by 10, 100, 1000 worksheet by themselves or with a partner.

Name _____ Date _____

average distances from the sun

1. Write the standard form of each number. The number is the approximate average distance in kilometers the planet is from the sun.

Jupiter

$779 \times 10^6 =$ _____ km

Earth

$150 \times 10^6 =$ _____ km

Uranus

$2.88 \times 10^9 =$ _____ km

Mars

$228 \times 10^6 =$ _____ km

Saturn

$1.43 \times 10^9 =$ _____ km

Venus

$108 \times 10^6 =$ _____ km

Neptune

$4.5 \times 10^9 =$ _____ km

Mercury

$57 \times 10^6 =$ _____ km

2. Order the planets on the lines below according to their average distance from the sun.

Closest

_____

_____

_____

_____

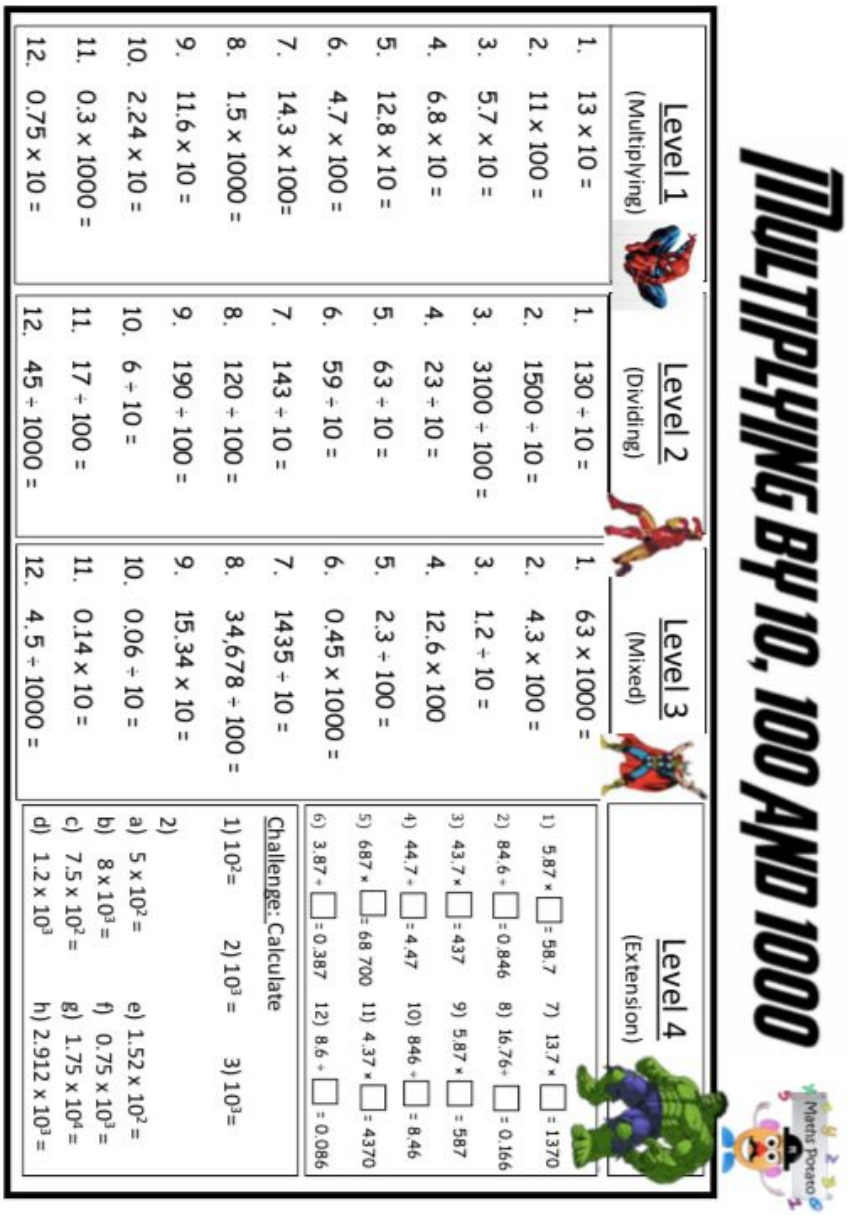
_____

_____

_____

_____

Farthest



Appendix J

Open Ended Math Problem Lesson Plan

Lesson Plan for Grade 6
Duration: 120 minutes
Prepared by Marissa Bartelt

OVERVIEW & PURPOSE

Practice for SBAC performance test. Practice solving multi-step problems as well as finding area

and perimeter.

OBJECTIVES

1. Review Multi-step problems
2. Review Area and Perimeter
3. Use Critical Thinking to Persuade Someone

MATERIALS NEEDED

- Worksheets
- Pencils

ACTIVITY

Directions given on the worksheets provided below.

Doggy Dilemma - The Problem

Your parents are finally letting you get a dog after YEARS of begging. However they need you to do something first (nothing comes without a little work). In your neighborhood there is a requirement that dogs must be kept in an enclosed fence (dog pen) in the backyard when they are outside.

Your parents need you to:

1. Choose a dog that is appropriate for your family.
2. Map out the fenced area (dog pen) in the backyard on the graph paper attached.
3. Choose a type of fencing from the table.
4. Calculate the cost of the fencing for your dog pen by finding the perimeter.
5. Calculate the area of the fenced dog pen.
6. Write a letter explaining all of your choices: the dog you chose and why, the square footage of your dog pen, the reason you made your dog pen the size that it is, and the type of fencing you chose. Don't forget to include the final cost of the fencing in your letter.

Details you should think about:

- ❑ Your backyard is 30' x 35'.
- ❑ Your little sister wants space to set up her pool in the summer. She needs about 50 square feet for that. She doesn't really want it to be inside the fenced area because she is afraid the dog will go to the bathroom in her pool. Please include that space in your backyard plan and label it POOL.
- ❑ When you decide the size of your dog pen, consider the activity level and size of the dog you are choosing.
- ❑ When you choose the fence type, you may want to consider how tall your dog is, and how high a dog can jump.
- ❑ For dogs that like to dig, you'll need to put chicken wire or large stones around the base of the fence to keep them from escaping.
- ❑ Do you need four sides of fencing, or can one side be the back of the house (which has a back door)? If you are using the house as one side of your fence, draw the house in your diagram.
- ❑ Label the dimensions of your diagram in feet. When you calculate the total perimeter, include that number inside your dog pen. Include the total area inside your dog pen as well.

ft

area = # ft^2

Doggy Dilemma - Information

Dogs available for adoption:

Dog Breed	Dog Details
Siberian Husky	Siberian Huskies are 35-60lbs as a full grown dog. They live between 12-14 years. They are bred to haul things for hundreds of miles. The ancestor of the Siberian Husky is the wolf. The average height of a Siberian Husky is 21-24 inches. Some Siberian Huskies have been known to jump up to 5 feet from a sitting position. They also love to dig.
Golden Retriever	Golden Retrievers weigh 60-75lbs as a full grown dog. Their life span is 10-12 years. Golden Retrievers are known for being kind, friendly, loyal, and calm. Golden Retrievers are often used as guide dogs. The average height is between 23-24 inches tall. Golden Retrievers require 2 or more hours of exercise daily.
Beagle	Beagles weigh 20-25lbs as a full grown dog. They have a great sense of smell and tracking instinct. The Beagle will typically live 12-15 years. Beagles have been bred for hunting rabbits. Beagles are excellent diggers. They grow to a height of 13-16 inches high. Some Beagles have been known to jump as high as four feet.

Types of fencing available for purchase:

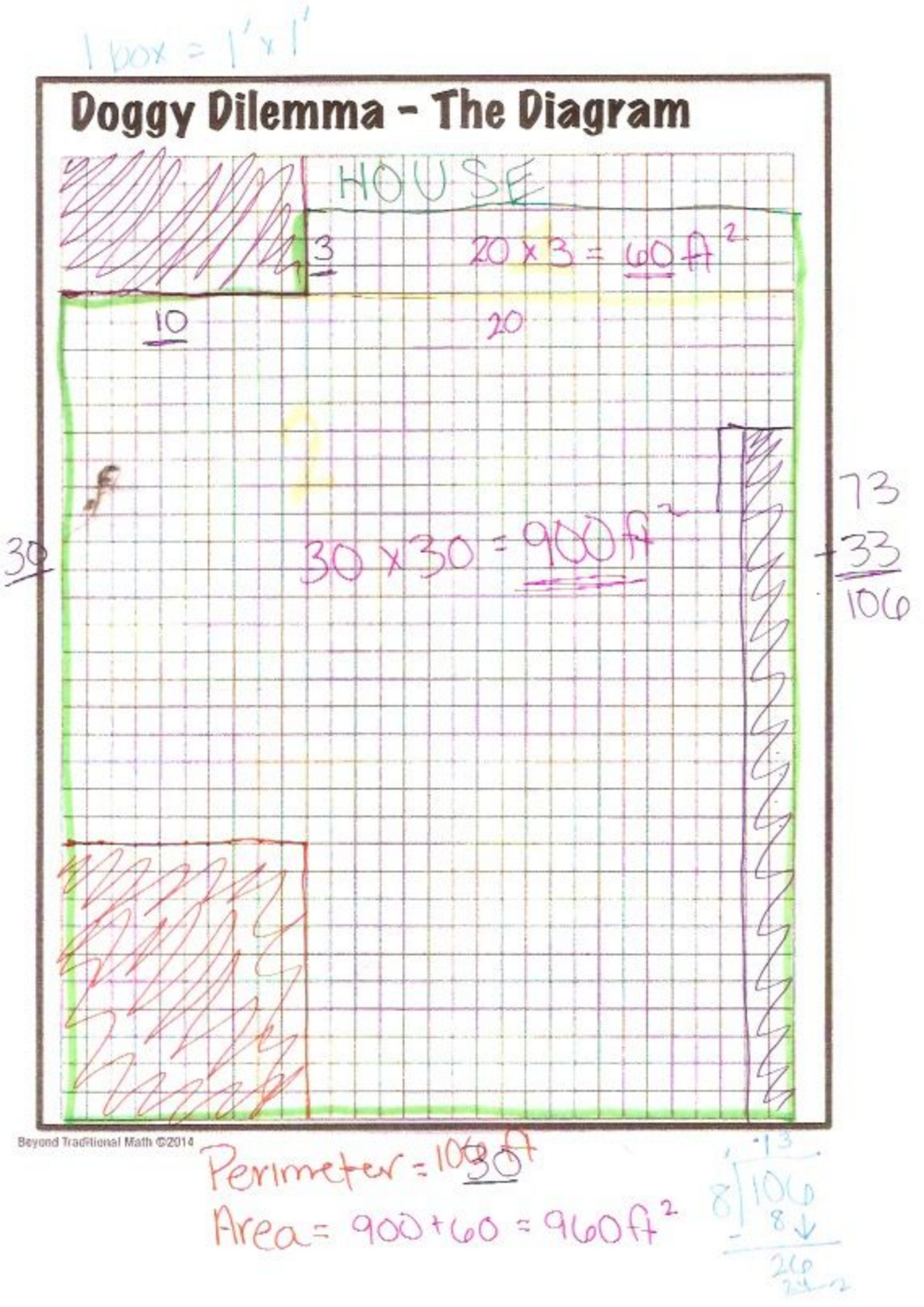
Fencing information	Fencing Cost
Chain Link – 6 feet tall, 50 foot roll	$256.00 per roll
Vinyl Panels – 6 feet tall, 6 foot sections	$151.00 per section
Wood Picket – 3 feet tall, 8 foot sections	$73.00 per section
Chicken Wire – 1 foot tall, 25 foot roll	$7.00 per roll
Large Stones – 1 foot brick	$1.00 per brick

Doggy Dilemma - Writing the Letter

Take some time to organize your thoughts.

Write a letter to your parents explaining all of your choices:

- ❑ the dog you chose and why
- ❑ the square footage of your dog pen
- ❑ the reason you made your dog pen the size that it is
- ❑ the type of fencing you chose.
- ❑ the final cost of the fencing


1 box = 1' x 1'
Doggy Dilemma - The Diagram
HOUSE
3
20 x 3 = 60 ft²
10
20
30
30 x 30 = 900 ft²
73
+33
106
Beyond Traditional Math ©2014
Perimeter = 106 ft
Area = 900 + 60 = 960 ft²