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Conquering Math Anxiety

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CONQUERING MATH ANXIETY

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Abstract

Mathematics is often perceived as a vigorous and demanding subject, and many students treat it as such, developing high affective filters which inhibit the process of learning math. This adverse reaction is the origin of math anxiety, a critical issue which plagues fifty percent of the U.S. population (Boaler, 2012). The purpose of this study is to promote math's value and lessen negative feelings towards the subject by implementing carefully structured, real-life warmups in the elementary classroom. This program evaluation utilizes a qualitative research method to explore what teachers should consider when incorporating real-life applications in math pedagogy. Student reactions to the warmups are analyzed through observation reflections. The findings of this study have revealed several considerations for educators when teaching real-life math: ineffective elements, ruminations, elements up for discussion, and successful elements.

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Introduction

During an interview, a famous stage actress was asked if she had ever suffered from stage fright, and if so, how had she gotten over it (Hageman, 2014)? The actress replied she had never gotten over it; instead, she learned to walk on stage and perform in spite of it (Hageman, 2014). Like stage fright, math anxiety is a paralyzing condition where panic and humiliation are central feelings. Even great mathematicians experience anxiety, though their anxiety is caused by something they do best and love most (Hageman, 2014). This introduction aims to define math anxiety, identify its significance, and present my study in eliciting positive attitudes towards math from fifth grade students.

Introduction and Landscape

“Math anxiety” is a term coined to describe any individual who experiences extreme tension or apprehension when asked to manipulate numbers in an academic setting (Tobias, 1978). These adverse reactions interfere with students’ ability to perform well on assessments, resulting in a decreased self-confidence and increased frustration with math. The severity of this issue heavily impacts students in the United States, as an estimated fifty percent of the population suffers from math anxiety, a third of school children end up in remedial math courses, and overall student interest in math is at an all-time low (Boaler, 2012).

Problem Identification

Elementary students develop math anxiety in high pressure situations. For example, timed tests are nerve-wrecking and stressful for students because of the emphasized time constraint, not the difficulty of the problems (Boaler, 2012). Since these timed tests cause an anxiety ridden atmosphere, students go on to attribute stress and pressure to the overall subject of math. As a result, students preserve the negative association throughout their academic experience, perpetuating math anxiety. Consequently, it’s unlikely those students will pursue mathematical careers or higher education in the future, which is a growing concern in the United States (Boaler, 2012). To alleviate math anxiety, elementary math curriculums must be structured to promote math’s value and lessen cynical beliefs towards the subject.

Significance of Study

If a student finds math to be useful, he or she is more likely to appreciate its value and develop a positive mindset towards the subject. Kids love to build, create, and apply their knowledge, and coupled with real-life applications, students will learn the power of the math they are exposed to. As follows, mathematics teaching methods for elementary students should be structured to define math’s relevance. To achieve this objective, this study adopts the pedagogy style of real-life applications to promote math as worthwhile and applicable to everyday life. This program evaluation utilizes a qualitative research method to explore what teachers should consider when incorporating real-life applications in math pedagogy.

Since I will be an elementary teacher, my findings will be useful in my future classroom as I want to focus my instruction on the real-life applications of math. My study will additionally make some suggestions for how real-life, hands-on pedagogy may help some students with math anxiety.

Methodological Overview

Mathematics curriculum design is the heart of my applied-research project. This project took place in a fifth-grade classroom in the Northern Colorado area during my practicum semester. I created a real-life warmups curriculum and implemented the activities in the classroom Monday and Wednesday mornings.

Research Question

After my warmup curriculum was taught, I explored the question: *What are some considerations for teachers when incorporating real-life applications in math pedagogy?* To carry out the study, a program evaluation methodology was used, and qualitative data was collected. My reflections were essential in completion of this project.

Ethical Considerations

A critical part of my research involved working directly with my participants to gain an understanding of every individual's experience before I made generalizations of the whole class. My need to refrain from making assumptions about the influence of my written program was essential. To address my bias, my cooperating teacher and thesis advisor served as neutral sources and partook in the data analysis process through triangulation.

Literature Review

The focus of the research on math anxiety has progressed from an identification of the problem to a review of different pedagogical styles designed to alleviate negative attitudes towards math. This literature review discusses how math anxiety is cultivated and its impact on students. A teachers' influence on students' attitudes will also be examined. This literature review concludes with a discussion of alternative math pedagogy methods.

Developing Math Anxiety

No substantial research can refute math anxiety (Hembree, 1990). As a result, much of the literature about math anxiety addresses its triggers. Hembree’s research provides an overview of what causes math anxiety. Through his meta-analysis, Hembree asserts students develop math anxiety through stressful feelings like punishment anticipation and self-esteem loss. Both feelings result in a heightened heartbeat, consequentially interfering with students’ performance abilities and culminating to low scores and negative perceptions of math (Hembree, 1990). Research by Wigfield and Meece (1998) supports Hembree’s conclusion of math anxiety causing poor test performance and low achievement, but their research builds on math anxiety’s relationship to negative impressions of math. Their investigation notes when students’ affective reactions to math are contempt, fear, nervousness, and failure, they are more likely to have math anxiety (Wigfield & Meece, 1998). These studies complement one another in showing how, through taxing and antipathetic feelings, students develop adverse reactions to math and perform poorly, and when they perform poorly, they reject the subject. Math anxiety is best depicted as a chain of reactions, and can become especially serious if perpetuated among young students.

Long Term Impacts of Math Anxiety

As the parameters of math anxiety were defined, and its reactionary nature revealed, researchers sought to analyze how younger students’ math anxieties influenced their futures. Willis’ research (2010) adopts a severe tone, arguing elementary students with math anxiety do not develop higher-order thinking skills. Higher order thinking includes creative problem solving and emotional response control, both of which are skills needed to successfully navigate math problems and handle increasingly complex technology (Willis, 2010). Difficult careers require candidates to have higher order thinking, raising a major issue for students with math anxiety. Other potential problems are discussed by Jameson (2013) who concluded elementary students with math anxiety are habitually disengaged with math, leading to low test scores. Students who are disconnected have a nominal foundation of math knowledge to reference during each sequential school year. As each higher math class attempts to go in depth with previous topics, those students fall further behind and continue to avoid and reject the subject (Jameson, 2013).

The snowball effect of math anxiety is also reflected in the research of Watts, Duncan, Siegler, and Davis-Kean (2014), whom discovered math anxiety in younger students predicts math anxiety in older students. The findings in this study reinforce the notion of young students enrooting math anxiety and persistently evading the subject, widening their gap in knowledge and negatively impacting their long-term success (Watts, et al.). Additionally, research by Fusion, Clements, and Sarama (2015) compliment Watts et al.'s research by emphasizing the importance for students to develop math knowledge progressively, as math anxiety continues to develop in the gaps of knowledge.

Teacher Influence on Math Anxiety

The high-pressure nature of the math classroom and its hand in eternalizing apprehension is widely discussed as the origin of math anxiety. However, teacher influence is also an instrumental factor in determining how students perceive math. Kulpa (2007) claims many elementary teachers report having bad memories and experiences with math, and inevitably struggle with teaching the same mathematical concepts to their students. As a result, students' performance is impeded as soon as they recognize their teachers' distaste and limited knowledge in the field of math (Kulpa, 2007). Beilock (2010) supports Kulpa's assertion of teachers' math anxiety negatively relating to their students' math achievement. Beilock (2010), however, concentrated on female students' academic achievement when their teacher had math anxiety. Beilock revealed when the teacher had math anxiety, the female students were pushed towards the stereotype "girls are not as good as boys at math" and females' test scores were lower at the end of the year (Beilock, 2010). Together, Beilock and Kulpa highlight the importance for teachers with math anxiety to practice autonomy to stop indirectly affecting their students and prolonging math anxiety. Luckily, a few teaching methods have been explored by teachers and researchers alike to begin the process of assuaging math anxiety.

Alternative Teaching Methods

After the perils of math anxiety were established, teachers and researchers began developing different curriculum designs and pedagogical styles aimed at mitigating students' resistive attitudes towards math. Each method discussed: subject integration, creative pathways, visual/kinesthetic, and real-life applications, is designed to cater to students' interests. This review does not intend to assert the dominance of one method over another, but rather serves as an investigation of several math pedagogy methods.

Subject Integration

Subject integration is a common curriculum design. The strategy of integrating math with another subject helps portray math as a relevant cross subject. Killion's (2001) study involved an integrated math and science class, citing lessons where fractions were taught by using clouds in the sky and number sense was discussed using the diversity of life. Killion's (2001) method aimed to use other content areas to "disguise" math, and the results of the study were promising, showing students were more open to learning math when they could see its relevance in other subjects. Similarly, Hatch and Smith's (2004) study combined math with physical education in order to increase student enthusiasm. Student participants in this study charted trajectories of thrown or kicked balls by physically acting upon the ball and using math to explain the motion of the ball (Hatch & Smith, 2004). Using this method was successful in improving students' impressions of math because students could visualize math through their actions, which made the work easier (Hatch & Smith, 2004). The success of Hatch and Smith's method was recreated in Palmer's (2008) study where students participated in combined music and math lessons. Students began to associate mathematical concepts with certain sounds, reflecting on how the music helped them in the memorization process (Palmer, 2008).

Apart from understanding how math is useful in other classes, students found they could personalize their work more when math was combined with other subjects. Rosenbloom's (2012) study cites a classroom where art was blended with math. Rosenbloom primarily draws on one example where her class observed the architecture of nearby buildings and analyzed their geometries (Rosenbloom, 2012). Using this method helped students to see mathematical concepts in their own way and make their work unique, and students commented they were more involved in the process of learning math (Rosenbloom, 2012).

Creative Pathways

The method of creative pathways is like subject integration because both methods disguise math with topics students may find more pleasing. Creative pathways are unique routes used to alleviate adverse impressions of math by attempting more personal connections. Powell (2010) tried a therapeutic approach to eliminating math anxiety by implementing teaching circles. These circles were small groups developed to support math anxious students and help them develop problem solving strategies (Powell, 2010). The results of Powell's (2010) method indicated student attitudes towards math did not change, but some students reported feeling reassured by knowing different strategies to use when solving math problems. A different creative pathway, implemented by researchers Maloy and Anderson (2010), also emphasized problem-solving strategies by executing web-based tutoring systems in the classroom where students practiced math problems through interactive web games. In this study, Maloy and Anderson noticed math anxious students performed better on tests and felt less agitated after experiencing the web-based tutoring system (2010). However, the researchers cited the helpfulness of the visual hints on the interactive game as a factor in improved scores (Maloy and Anderson, 2010).

For their study, Sengul and Dereli (2013) designed a math lesson plan using cartoons to try a more humorous approach to representing numbers. Integers were taught with 17 pictures which told little "stories" of the numbers and the operations done to them (Sengul & Dereli, 2013). At the end of the unit, students reported being more entertained with their work and even enjoyed math more because it was represented in a way they found more appealing (Sengul & Dereli, 2013). Likewise, in a lesson cited by Drabble (2013), math was made more enticing when spaghetti noodles were used to depict trigonometric graphs and the unit circle. Drabble (2013) noted the students involved in the study asked for more similarly constructed lessons.

Though creative routes to teaching math are unique and enjoyable, this style may not be the most efficient and expansive way to teach all units in math. As a result, researchers and teachers alike opted for more hands-on methods where students could see and feel math, as opposed to portraying it as an abstract subject on paper.

Visual and Kinesthetic

Another common method of teaching math targets visual and kinesthetic senses to bring math to life. To showcase hands-on mathematical learning, Williams, Poveda, Kapila and Iskander (2012) incorporated LEGOs into their math curriculum to model geometrical problems. Participants in the curriculum demonstrated a positive transformation in perceptions of math because they enjoyed being able to build tangible models and analyze them to answer problems (Williams et al, 2012). To further pursue hands on work, in Quander's (2013) study, GeoGebra was implemented in the classroom for students to view 3D models. This method encouraged the use of manipulatives for students to stimulate their visual and tactile senses, which was deemed effective in changing student perceptions, as student reflections documented their engagement engaged in the process (Quander, 2013).

More recently, researchers Westenskow and Moyer-Packenham (2016) analyzed the use of manipulatives in teaching fractions, and recognized how students became craftsman and devised ways to solve the math problems. In student reflections, the participants described their increased motivation to discover the answers for themselves when using the manipulatives to support them (Westenskow and Moyer-Packenham, 2016). This method highlights the main intention of using manipulatives—for students to be able to decipher math problems when they don't necessarily know how to approach the problem on paper.

Real-Life Applications

Trends in alternative math pedagogical methods highlight the importance of student engagement. Real-life applications differ from the aforementioned methods because students are actively involved in "big picture" thinking. When math comes off the page and is applied to everyday life, students' content knowledge increases and they learn math's importance in the world, thus developing an appreciation for the subject.

Students learned the worth of math in Weyhaupt's (2012) study when they used actual ballot data from the city of San Francisco and improved their understanding of functions and algorithms. Weyhaupt found teaching students with legitimate data required students to understand the social influence of their findings and learn how their observations can be represented mathematically (2012). As politics is a life altering subject, students were more engaged with their work (Weyhaupt, 2012). Likewise, in a journal article, Kulkin (2016) used her experience and observations as a classroom teacher to document her students' changed perceptions of math as she implemented real world applications into her lessons. In one lesson, Kulkin (2016) taught averaging decimals by using landing times for different objects attached to parachutes. In a different lesson, Kulkin (2016) described fractions using quilting. Citing those lessons, Kulkin found real world applications helped her students to understand the importance of math and its value in the world.

Similarly, in Althauser's (2016) study, economics and math were integrated in a lesson and students became actively engaged when they implemented a food drive to support their learning. Students used math to chart the success of the food drive, and reported feeling connected to what they were learning and noticed how math could help them make a difference (Althauser, 2016). This study also revealed students were more motivated to learn math because they felt their work was making a visible change (Althauser, 2016). In Eubanks-Turner and Hajj's study (2015), students were taught about the coordinate system while studying a city preparing for a Mardi Gras parade. Students used algebra to find the most optimal pathways for the parade to march and developed an awareness of how algebra can be used to model real-life situations and make a difference (Turner & Hajj, 2015). A student's reflection noted "Doing math [like this] really shows its purpose in life outside the classroom" (Turner & Hajj, 2015, p.497), which is ultimately the goal of the real-life applications pedagogical style.

Mathematics often leaves students discouraged and pondering "when am I ever going to use this?" The method of real-life applications aims to dismiss this attitude by redirecting students to explore deeper questions like "what did I learn?", "how is what I learned important", and "what can I do with what I learned?". Real-life applications of math help students to actively think about how they can better their lives through math, which is important in contributing to an increasingly technology dominated world.

Summary

Math anxiety is a common problem among students in the United States, and its impact is grave, as students' test scores are falling behind other countries, and many students lack interest in pursuing mathematical careers (Boaler, 2012). Math anxiety develops through stressful variables which distract from the math at hand and are largely irrelevant in the solutions for the problems (think timed tests). The process of eliminating math anxiety begins with altering teaching practices in elementary curriculums to cater to all students and promote math as useful in everyday life. If students find math to be useful, they won't dismiss the subject. There are many approaches teachers and researchers alike have developed to assuage math anxiety: subject integration, creative methods, manipulative use, and real-life applications, but as the literature shows, there is no best way to teach math.

Much of the literature about math anxiety addresses classroom attitudes holistically. This study intends to focus on the overall essence my program created. My warmup program adopted the real-life applications pedagogy style, and I explored what teachers should consider when incorporating real-life applications in their teaching style.

Philosophical Paradigm

The constructivist paradigm arose to ponder the underlying assumptions and methodology of the postpositivists' theory driven paradigm (Mertens, 2005). Mertens (2005) asserts the philosophy of constructivism is structured on hermeneutics, a study of interpretive understanding or meaning. By using this viewpoint, constructivists tend to believe reality is created socially, resulting in the need for researchers to interpret meaning by adopting a certain standpoint. Constructivists recognize their work is reflection of what they value and their perspective cannot be changed (Mertens, 2005).

This world view is important because constructivists guide their thinking along the lines of "knowledge is socially constructed by people active in the research process, and researchers should attempt to understand the lived experience from the point of view of those who live it" (Mertens, 2005, p. 16).

Elementary age students who suffer from math anxiety habitually avoid mathematics, making the phenomenon difficult to overcome. As a result, researchers and teachers are tasked with analyzing best practices and effective teaching methods to tend to the students who need the support most. The constructivist paradigm is the most applicable research approach to implement when considering math anxiety because it will emphasize the feelings and perspectives of the students in constructing knowledge about how to assuage their anxieties. Reflecting on the considerations presented by the real-life applications model in this project will rely on students' observable reactions to the warmups, which is why the constructivist paradigm is a good fit.

Axiology

The nature of ethical behavior in the constructivist paradigm does not assume a "morally neutral, objective observer" will get the facts correct (Mertens, 2005, p. 16). Instead, constructivists argue a trustworthy and authentic study must have a balanced representation of views (Mertens, 2005). In world view, constructivists' ethical principles respect the relationship between researchers and participants but assert the furtherance of social justice (Mertens, 2005). In this study, the accounts and experiences of all participants are considered valid and will only be used to improve mathematics instruction. For example, as students reacted to the lessons, any observed interactions were considered only when making recommendations for the program.

Ontology

The nature of reality in the constructivist paradigm is socially constructed, meaning "multiple mental constructions can be apprehended, some of which may conflict with each other, and perceptions of reality may change…" (Mertens, 2005). In simpler terms, the term "reality" means something different to each individual person, and there is no single correct interpretation. In world view, constructivists reject the idea of one reality, and make their objective to understand the multiple perspectives involved in socially constructing meaning and knowledge. My study relied on noting the wide range of students' reactions to math when making recommendations for this program.

Epistemology

To come to knowledge, the constructivist "opts for a more personal, interactive mode of data collection" (Mertens, 2005, p. 19). This paradigm assumes data and outcomes are rooted in context and the participants, and suggests there is a systematic way to assemble those interpretations. In world view, both the researcher and the participant co construct knowledge, and the participants drive the knowledge. My study was largely based on working directly with my participants to produce an outcome on the considerations of implementing real-life applications in mathematics pedagogy.

To guide my research, I collected qualitative data and emphasized the context of the data. Using qualitative data correspondences with the assumption of the social construction of reality being only achievable through interactions between the researchers and the participants (Mertens, 2005). Observation reflections were taken over the course of this study to obtain multiple perspectives and to better interpret meanings to compare with one another.

Methodology

The rationale of this program evaluation is reveal some considerations when using a real-life applications pedagogical style to teach math. This study aimed to emphasize the feelings and perspectives of the class as a whole. A constructivist philosophical paradigm was adopted for this research because the study is largely based on the participants and researcher co- constructing knowledge. The chosen methodology was a program evaluation, and qualitative data was collected. Ethical considerations and my role as a researcher were carefully monitored throughout this research project.

Methodological Strategy

After implementing the real-life applications pedagogy in an elementary mathematics classroom, my research naturally progressed to a need for a systematic evaluation to determine the worth or merit of my warmups. The objective of real-life applications is to improve students' perceptions towards math, so the research was concluded with a big picture view of the model's influence on students' attitudes. To address this desired outcome, a program evaluation was completed. In this methodology, "evaluation reasoning will include the selection of criteria, measuring if the standards are met, and synthesizing the results… for the purposes of accountability, improvement, or enlightenment" (Lapan & Quartaroli, 181).

Research Question

A program evaluation was an appropriate methodology to answer my research question: *"What are some considerations for teachers when incorporating real-life applications in math pedagogy?"*

My methodology and research question match because I analyzed my data (observation reflections) to get a sense of the students' attitudes towards math. From there, I reviewed my results and made appropriate recommendations for future teachers who want to use real-life applications in their teaching styles.

Program Evaluation

A "program" can be defined as, "any effort that includes a set of expectations, goals, guidelines, procedures, and other characteristics that form any enterprise that aims to create a desired result" (Lapan & Quartaroli, 184). Programs are organized into three segments: antecedents, transactions, and outcomes. The program antecedents are the plans or activities which occur in preparation for the implementation. Program transactions are the functions and operations of the program. The program outcomes are the actual effects of the program which justify the program's purpose.

Program evaluations involve the idea of assessing or judging worth. Worth is determined by selecting a set of criteria, judging the criteria by using benchmarks for growth or expectation, explaining how the data will be collected, and synthesizing the data so the evaluator may make clear recommendations about the program (Lapan & Quartaroli, 185). One specific purpose of a program evaluation is to "improve the program by collecting data that will offer answers to program participants about effectiveness" (Lapan & Quartaroli, 185). Improvement evaluations are designed to highlight positive aspects of the program and correct any issues.

For the evaluation, the specific focus will be on the stakeholders and why they are taking interest in the results of the research. However, it is important to consider the participants and their role in the research. In a program evaluation, data collection must allow the researcher to obtain in depth information and help each participant reveal a perspective no one else has. In this study, observations of the students was the only method used to achieve the necessary transparency.

Using a program evaluation in my project is appropriate because I implemented a math model, real-life warmups, in the classroom and determined some considerations for teachers when incorporating real-life applications in math pedagogy. Evaluation differs from other forms of research in its intent because the findings are used to inform decisions about improvement, (Lapan & Quartaroli, 200), and I am looking to improve math instruction in elementary classrooms.

Methodological Weaknesses

When the evaluators have close ties to the evaluated program, the researcher may have an increased potential for bias (Lapan & Quartaroli, 195). To be ethical, a program evaluation must include the perspectives of all relevant stakeholders, not just the one who is reviewing the program (Lapan & Quartaroli, 195). To address this inherent vulnerability, researcher triangulation is used. Using triangulation, an outside professional evaluator draws conclusions from the collected data, and then the inside evaluator checks for discrepancies. The inside and outside evaluators will not communicate with one another directly, but will relay communications to a third person, forming a triangle. By this method, all findings may be represented without regard to the interests of those in charge or sponsoring the study (Lapan & Quartaroli, 195). Should any discrepancies occur, the third evaluator will examine the data, disputed conclusions, and choose the most apt conclusion. My thesis advisor, cooperating teacher, and myself were the parties involved in the triangulation.

Researcher Role and Positionality

My interest in this study stems from my previous experience with math. When I was in elementary school, I struggled with math because the subject seemed like an endless mass of numbers and I could not visualize how manipulating them would be useful to me in the future. In third grade, I fell behind grade level and I was placed in a “bottom level” math group, which meant I was given easier math problems to tackle. However, my distaste for math grew because I felt completing the simpler problems was not worth my time if my peers were doing more challenging work.

The only reason I passed elementary school, middle school, and high school math was because of my father, the best teacher I have ever known. My father knew exactly how to break down and simplify each question so I could easily follow the steps and recreate the magic in my other homework problems. When I grew frustrated and lost sight of the importance of the math I was learning, my father always found a real-life application for the problem I was solving. His big picture thinking always absolved me of any anguish towards the numbers on my paper and helped me move forward with the math. Using his perspective has inspired this project, as I strive to be half the math teacher to my future students as my father is to me.

Because my elementary experience with math was so poor, I want to present math as a worthwhile subject to my future students so they will not view math as useless, the way I had when I was their age. Therefore, any bias in this research stems from my desire for my math warmups to succeed in improving student perceptions of math.

Research Methods

A program evaluation is the chosen methodology for this research, rendering the participants and setting of my project to be of the utmost importance. As follows, the data collection method will be qualitative to capture the essence of every participant's experience in the study. As there is no Institutional Review Board certification for my applied-research project, I was only able to collect one form of data: reflections.

Setting

As part of my practicum experience, the site of this project was a fifth-grade classroom. The real-life warmups instruction occurred during math time on Mondays and Wednesdays from approximately 8:15 a.m.-8:30 a.m.

Participants

The class sample consisted of approximately twenty predominately White, low to middle class students in fifth grade. Nearly the entire class had been educated in a STEM environment, and every person in the class tested at or above the 85th percentile on last year's state math testing.

Data Collection and Analysis

Observing my students will be essential because, "Classroom observation is the most direct way to measure instructional quality" (Clare & Aschbacher, 2001, 40). As this study took place during my practicum semester, I observed my students throughout my time in the classroom, and I completed a reflection for each day I taught a real-life warmup. My project used one form of data: reflections.

Qualitative data was used in this study because it more accurately highlights some considerations for teachers when incorporating real-life applications in math pedagogy. For each real-life warmup implemented, I wrote a reflection of my observations of the students' reactions as a whole. I looked for evidence of positive or negative reactions (facial and verbal expressions and gestures), as well as overall student engagement. Every reflection discussed the ways my students reacted to the corresponding warmups.

The qualitative data in this research project was used with the intention of gathering the full impact of my real-life warmups curriculum. This data helped the researcher (myself) and my students co construct knowledge about how real-life applications in math pedagogy influences students' attitudes towards math.

In a classroom setting, authentic observations are conducted through watching students' reactions. Adverse or positive reactions are easily recognizable in most students, especially during collaborative work where students tend to project their emotions. For my warmup reflections, interactions between students and their expressed reactions were especially discussed.

The analysis of the reflections was completed through the process of coding. Each reflection was reduced to meaningful segments, each segment was named, and the codes were combined into broader themes (Creswell, 2007). This part was completed November 19, 2017. On December 3, 2017, the recode procedure (Creswell, 2007) was implemented, and I reviewed every ten lines of my observation reflections to see if my interpretations were the same.

Finally, the interpretation of the data was presented thematically. For instance, if a student was to express, "Math is fun this way!", I discussed the comment in my reflection, named the comment/segment "fun", and characterized "fun" under the broader theme of "successful elements".

Research Rigor

Most qualitative researchers recognize and document the worth of a project by assessing the credibility, accuracy of representation and authority of the writer of the work (Krefting, 1990). This program evaluation aimed to achieve truth value and applicability by using Guba's Model of Trustworthiness. This model has been well developed conceptually, is appropriate for qualitative designs, and ensures rigor of the research (Krefting, 1990). The four strategies included in this model are: credibility, transferability, dependability and confirmability.

Credibility

Triangulation is a powerful strategy in enhancing the quality of research (Krefting, 1990). This idea is based on converging multiple perspectives for a mutual confirmation of data to ensure all aspects of a phenomenon have been investigated (Krefting, 1990). As the data analysis for this program evaluation was largely based on my observations, my thesis advisor cross checked my data to see if her interpretations were like mine. This way, distortion from my bias was minimized.

Transferability

It is critical for researchers to provide dense background information about the informants, research context and setting to allow others to assess how transferable the findings are (Krefting, 1990). This study is conducted through a constructivist paradigm; thus, rich description will be necessary to document the multiple perspectives of all students. As a researcher, I needed to ensure my data and description of the setting and participants allowed for transferability judgements to occur. To achieve this transparency, I provided rich descriptions of the setting, participants, and my observations.

Dependability

To increase the dependability of my research, I used the code-recode procedure during the analysis phase of my study (Krefting, 1990). In phase one of my data analysis procedure, I spent meticulous time coding my observations. For phase two, I waited two weeks before returning to the data and I recoded every ten lines to check for accuracy.

Confirmability

To address my interpretation confirmability, I used the audit strategy. Each step I took to analyze data was documented through a natural progression of events to explain any decisions I make. This strategy involves an external auditor following through my project to assess if he or she arrives to comparable conclusions (Krefting, 1990). My auditor was my thesis advisor, and she considered the process of research as well as my product, data, findings, interpretations and recommendations (Krefting, 1990).

Conclusions and Future Study

At the classroom level, to gain an understanding of how to assuage negative attitudes towards math, it's necessary to conduct studies which will provide evaluations of different pedagogical methods. This program evaluation explored student attitudes when teaching real-life math through qualitative data methods. The conclusion of this study provided an overview of key considerations when implementing real-life applications in the classroom. As this study focused on viewing the classroom holistically, future routes of study may consider the male versus female ratio aspect of math anxiety, or teacher influence on students' math anxiety.

Data

Over the course of the semester, nine warmups were taught between September 25, 2017 and October 30, 2017. Each warmup experience lasted about 15 minutes, and students chose between working on the problems with their table groups or on their own. Each warmup in the program is connected to a Colorado Model Academic Standard and addresses a real-life scenario. The topics for the real-life warmups ranged from decimals, rounding, perimeter, area, volume, fractions, algebra, 3D figures, surface area, combinations, and division. Most students had background knowledge with each of the content areas presented, but the warmups were solvable with invented strategies as well. The reflections of each warmup include student reactions and details in how successful each warmup was in generating positive perceptions of math.

Findings

Four themes emerged through the coding process: ineffective elements, successful elements, ruminations, and elements up for discussion. Ineffective elements included characteristics of the real-life warmups which did not produce useful results. Successful elements incorporated any features of the real-life warmups which correlated with positive perceptions. Elements for rumination are aspects for teachers to ponder when presenting real-life math warmups. Elements up for discussion touch on pedagogy debates for teachers. These four themes are discussed at length in the next section.

Warmup Title	**Meaningful Segments**
Real-Life Decimals and Rounding	series of problems, time constraint, sense of urgency, quick vs. efficient, anxiety
Real-Life Time and Decimals	calculate elapsed time vs. using technology, struggling, weak real-life connection

Real-Life Perimeter and Area	missing key information, struggles detracted from the point of the warmup, perseverance
Real-Life Fractions	procedural understanding, visual representations, conceptual thinking
Real-Life Algebra	unfamiliar format, “what is the point of solving for x”, invented strategies, deep thinking of the meaning of x
Real-Life Volume	engaged, understood significance of word problem
Real-Life 3D Figures and Surface Area	enjoyment, building, understood
Real-Life Decimals and Combinations	repetition, real-life integrated, poor perceptions of math
Real-Life Division	fun, productive discussion, remainders

Meaningful Segment	**Theme**
series of problems, repetition, time constraint, urgency, struggles detract from the point	ineffective elements
missing key information, unfamiliar format	ruminations
invented strategies vs. formulas, technology use (with elapsed time), procedural vs. conceptual,	up for discussion
perseverance, invented strategies, productive discussion, hands-on, significance understood	successful elements

Implications and Recommendations

After reviewing each warmup reflection, I have been able to explore what teachers should consider when implementing real-life applications in math pedagogy. The observations I made during my practicum semester have provided me with certain implications for my warmups, and through reflection, I have made recommendations to improve my real-life warmup program.

Ineffective elements included characteristics which were not helpful in reducing students' math anxiety. Students may have been stressed or displayed other negative reactions. For example, when students were given a time constraint and were asked to power through a series of repetitive problems, positive perceptions of math were not cultivated. When students were under pressure and felt a sense of urgency to finish the problems, their focus deviated from the real-life aspects of the problem. In this instance, students felt the pressure of math anxiety, negatively impacting their attitudes towards math. Instead, speed became more important than understanding the math at hand. One exemplar warmup which demonstrated the most ineffective elements was the Time and Decimals Warmup. Students were asked to calculate elapsed time and represent the time in the form of a decimal. This was considered an ineffective warmup because the data showed the time constraint, urgency, and overt repetition was not helpful in generating positive perceptions of math, as many students reported feeling anxious. For a more meaningful warmup, students could have used clock manipulatives to represent elapsed time, or used invented strategies to solve the problems. Overall, for the future, math warmups should not involve repetition or a time constraint, unless the real-life application calls for such.

Successful elements of my warmup program incorporated instances when students expressed lots of positive reactions. When students understood the purpose of the math problems they were solving, they could come up with their own invented strategies and practiced perseverance until the problems were completed. In relation to real-life, students demonstrated problem solving skills to solve various issues. To assist with solutions, many students opted to use manipulatives, furthering their tactile understanding. Since students were involved with their work, they could engage in productive discussions about their strategies. One exemplar warmup was with the Real-Life Volume Activity. In this lesson, students were asked to calculate the volume of juice boxes so they could market and sell juice for a juice box company. Students were engaged and understood the significance of what they were learning. Another exemplar warmup was with the Real-Life 3D Figures and Surface Area, as students reported feelings of enjoyment for building the figures. Furthermore, students understood what they were doing, as they had a visual representation. For the future, math warmups should be conversation starters for inquiry and building, not simply a resource to get students "warmed up".

Elements for rumination are aspects for teachers to think about in order to deliver more meaningful real-life instruction. Two areas which threw students for a loop were warmups which missed some key information, or where information was presented in an unfamiliar format. One exemplar of this was the Real-Life Algebra Warmup. Before students even had a chance to attempt the math, they were immediately turned off by the unfamiliar format and language. Another exemplar was with the Real-Life Perimeter and Area Warmup. Even though students understood the concept of area and perimeter, the problem (intentionally) did not include key information, so the students had to struggle to come up with the key information, as well as complete the problem. The added struggles detracted from the overall point of the warmup. Though not all real-life scenarios will accommodate these aspects for students, consistency in the classroom is important. For the future, if the real-life warmups are going to require students to problem solve to find missing key information, scaffolding will be necessary for students to make connections. Also, the warmups should be modified to make sure all terminology is the same as what is presented in class. Eliminating variance will help contribute to stability and promote confidence in students.

Elements up for discussion touch on pedagogy debates for teachers. One of the main debates in math education is whether procedural knowledge of math should be drilled, or if students should adopt a conceptual understanding of math. In procedural knowledge, students learn by memorizing steps and processes, and in conceptual knowledge, students focus on addressing “why” questions. These warmups focused on conceptual understanding, as if students know why they take certain steps to solve problems, they are more likely to understand and enjoy the problems. Another debate in math education is the use of technology: specifically, calculators. I would argue calculators don’t interfere with student understanding because these devices still require a correct input to output a correct answer. Many of the problems incorporated multiplication problems with lengthy solutions, potentially detracting from the point of the problem. Finally, one last debate my warmups highlight is the difference between invented strategies and formulas. Students should not be forced to complete math problems through an algorithm, as was presented in the Real-Life Algebra Warmup. Instead, students should be encouraged to use their own strategies, and make modifications to their strategies so they are completing problems efficiently.

Despite the amount of time I spent planning these warmups, there are many components of teaching besides lesson delivery which impacted the outcome of my project. Most importantly, knowing the progression of students' math knowledge from Kindergarten to fourth grade would have clued me into what background students had in certain subject areas. This fluency and interpretation of the Colorado Model Content Standards will come with time and practice. In addition, I found my success also relied heavily on what kind of classroom environment was established. If I had established a classroom community focused on risk taking and fixing mistakes, perhaps students may not have checked out when receiving an unfamiliar warmup. Another aspect which may have influenced the effectiveness of my warmups was with the relationships I built with the students. As a practicum student, I was only in the classroom twice a week, which was not a lot of time to get to know the students, as well as deliver my warmups.

Ultimately, the real-life warmup program was excellent practice in reflecting on my teaching ability. Though I experienced success and failure, and have walked away with more considerations than conclusive steps to take when implementing this program, Students often have negative reactions to math, as the subject can be perceived as an abstract activity on paper. However, through completing this project, I now realize what elements are successful in teaching real-life math. As I move from a practicum student, to a student teacher, to a licensed professional, I will take these considerations with me to grow into the most effective and passionate teacher I can be.

APPENDICIES

Appendix A: Real-Life Warmups

<u>Real-Life Decimals and Rounding Warmup</u>

Answer the questions below to decode the message!

Round each of your answers to the nearest TENTH.

2.3 + 4.88 = _______ = F

5.26 - 3.1 = _______= I

8.98 – 4.79 = _______ = H

7.45 – 2.39 = _______= S

213.8 - 72.9 = _______ = A

547.1 – 3.4 = _______= L

23.78 + 87.5 = _______ = R

67.9 + 21.1 = _______ =E

Once you have answered all the questions and rounded the answers to the proper place value, decode the message below.

_____ _____ _____ _____   ____ ____   _____ _____ _____ _____ !!

7.2 140.9 543.7 543.7   2.2 5.1   4.2 89 111.3 89

Real-Life Time and Decimals Warmup

Ms. Ellett's cat, Leo, loves to sleep.

Every day, Leo wakes up, eats breakfast, and takes a morning nap starting at 9:42 a.m. He sleeps until 11:57 a.m.

How long does Leo sleep in the morning? _____ hours and _____ minutes

How can you write your answer as a decimal? _____ . _____
(Hint: How many minutes are in ¼ of an hour?)

When Leo wakes up at 11:57 a.m., he likes to sit by the window for a few hours before he finds lunch. After lunch, Leo is very sleepy and falls asleep, usually at 2:12 p.m. He snoozes until 4:57 p.m.

How long does Leo sleep in the afternoon? _____ hours and _____ minutes

How can you write your answer as a decimal? _____ . _____

After 4:57 p.m., Leo is awake until bedtime. At 11:00 p.m., he settles down for bed and doesn't get up in the morning until 8:30 a.m.

How long does Leo sleep at night? _____ hours and _____ minutes

How can you write your answer as a decimal? ______ . ______

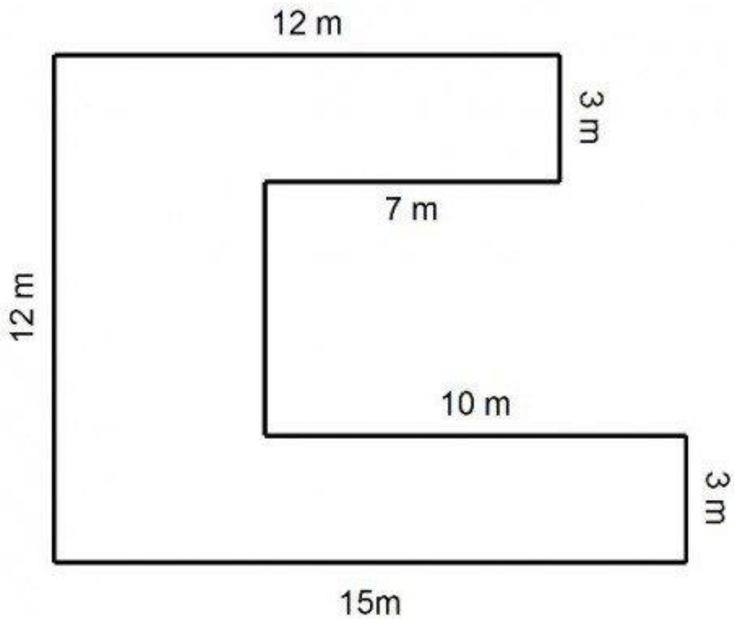
How many *total* hours does Leo sleep per day? ______ hours
(Hint: Your answer should be a decimal number.)

Leo slept in for an extra 30 minutes yesterday. What fraction of the day did he sleep?

Real-Life Perimeter and Area Warmup

Mark is building a garden in his backyard.

He drew a picture of what he wants the garden to look like, but he needs help figuring out how much fencing he will need to buy to go around the perimeter of the garden. Mark also needs to know how much area he will have to plant flowers in his garden.



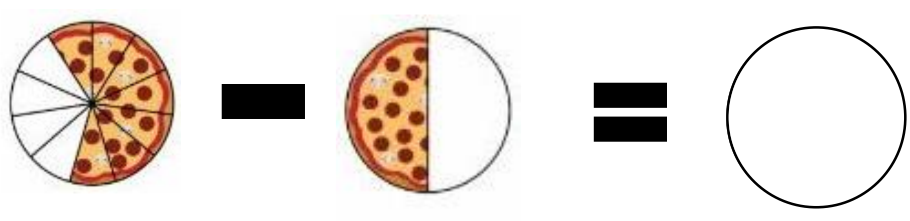
What is the **perimeter** of the garden?

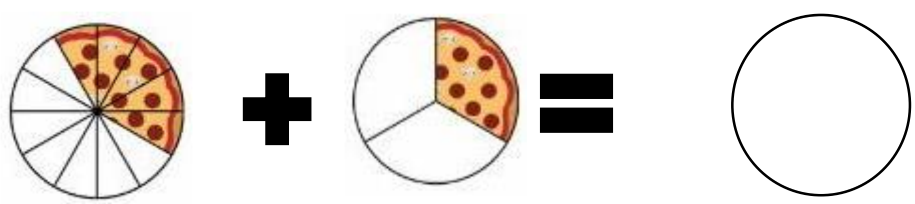
What is the **area** of the garden?

Mark is going to the store to buy the materials. Did you remember to put units on your answers so he won’t be confused?

Real-Life Fractions Warmup

Tony owns a pizza restaurant and allows his customers to make fancy order requests. Help him decipher these orders.

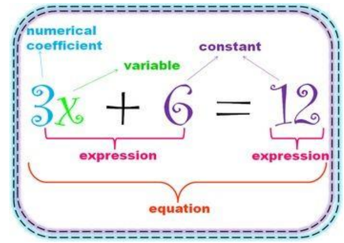




Add all of your answers together to find out the total number of slices Tony sold.

Real-Life Algebra Warmup

Read each situation. For each problem, you will define a variable (x), write an equation (choose from the equation bank), and solve for x using algebra (see right for **an example**).



Equation:	3x + 6	=	12
+ or -	-6	=	-6
New Equation:	3x	=	6
X or ÷	3	=	3
Solution:	x	=	2

Situation 1: Brody bought packs of gum to give to his friends. Each pack cost \$4. Brody spent a total of \$12 on gum. How many packs did he buy?

x =

Equation:

Solve for x:

Equation Bank:

$\$\ 4x = \$\ 12$

$\frac{x}{4} = 3$

Situation 2: Brody stumbled upon a litter of 12 puppies. He wants to split the group equally among his 4 friends. How many puppies did each friend get?

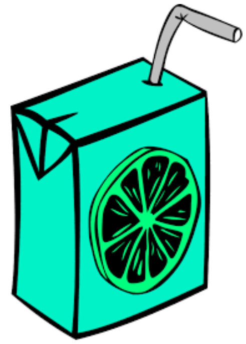
x =

Equation:

Solve for x:

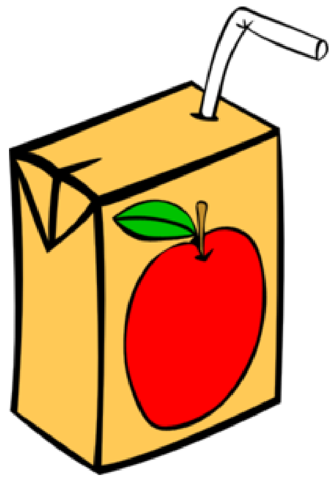
Real-Life Volume Warmup

Gracie is the owner of Gracie's Specialty Juices. She offers juices in three flavors: Blue lemonade, apple, and purple grape.



Before Gracie can sell her juice, she needs to know the volume of each of her juice boxes. This information will tell her how much liquid each of her juice boxes can hold.

Feel free to label the diagrams on the right to help organize your thinking.



Dimensions of the Blue Lemonade box:
Length: 8 cm
Width: 4 cm
Height: 12 cm

Volume= _________ cubed cm

Dimensions of the Apple box:
Length: 6 cm
Width: 4 cm
Height: 15 cm

Volume= _________ cubed cm

Dimensions of the Purple Grape box:
Length: 10 cm
Width: 6 cm
Height: 14 cm

Volume= _________ cubed cm

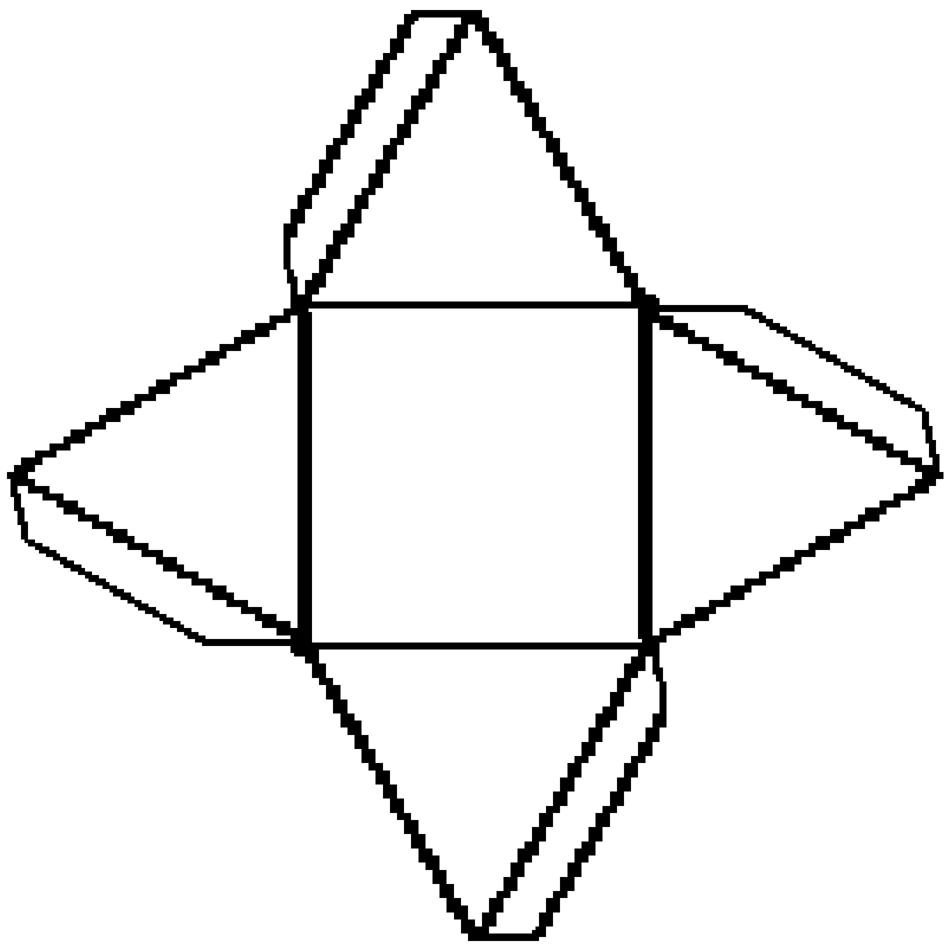
Real-Life 3D Figures and Surface Area

Makira wants to spoil her dog, Benji, by building him a square pyramid dog house. Below, Makira has drawn a model of what she wants her dog's house to look like.

Task #1: Cut out the shape below. Then, fold the tabs and glue the figure together so it resembles a 3D square pyramid.

Task #2: Makira wants to line the entire square pyramid with blankets. Help Makira find the surface area of the pyramid so she knows how many square feet of the blanket to buy. Write your answer somewhere on your pyramid.

Information: Each side of the square base is 6 cm long. The height of each triangle is 4 cm tall.



Real-Life Decimals and Combinations

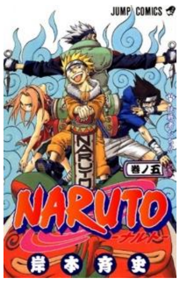
Jeremiah is extremely hungry and ready for lunch! As he looks over the food menu (see left), Jeremiah notices each food item at the restaurant is set at a different price.

Jeremiah only has $5. How many different food combinations can he buy?

Real-Life Division

Solve each problem with the strategy of your choice. Write a sentence discussing why your answer makes sense.

Lei reads 347 anime books over 57 days! About how many books did he read per day?



Lei arranges 69 unifix cubes in three columns. How many unifix cubes are in each row?

Lei is making Halloween food for the students in his class. He makes 500 spider treats, and there are 20 people in his class. How many treats will everybody get?

Appendix B: Warmup Reflections

Real-Life Decimals and Rounding Warmup (10 minutes)

Content Area: Mathematics
Standard: 1. Number Sense, Properties, and Operations
Grade Level Expectation: Fifth Grade
Concepts and skills students master:
2. Formulate, represent, and use algorithms with multi-digit whole numbers and decimals with flexibility, accuracy, and efficiency.
Evidence Outcomes
c. Add, subtract, multiply, and divide decimals to hundredths. (CCSS: 5.NBT.7)
i. Use concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction. (CCSS: 5.NBT.7)

Lesson Date: 09/25/2017

Task: Students solve various addition and subtraction problems involving decimals. Each answer is rounded to the nearest tenth, and students make note of the corresponding letter of their answer. Once all the problems are solved, the message at the bottom of the page can be decoded.
The message reads: Fall is here!!

Real-Life Connection: Being able to crack codes is a great skill, especially if one works for United States' Central Intelligence Agency. When students complete this assignment, they can imagine how American spies need to work quickly and make sure their work is accurate. The reward? A decoded secret message.

Reflection: When presented with a series of problems and given a time constraint, students may have experienced feelings a timed test would induce. The sense of urgency to crack the code first caused students to rush through the work, not paying close attention to each problem. In turn, this created issues with decoding the message. If this warmup is to be assigned, students being meticulous and thoughtful when solving problems should be emphasized. Just like with a spy in the CIA, the goal of the warmup is not solely to be the quickest; the work should be done accurately and efficiently.

Real-Life Time and Decimals Warmup (10 minutes)

Content Area: Mathematics
Standard: 1. Number Sense, Properties, and Operations

Grade Level Expectation: Fifth Grade
Concepts and skills students master:
2. Formulate, represent, and use algorithms with multi-digit whole numbers and decimals with flexibility, accuracy, and efficiency.
Evidence Outcomes
c. Add, subtract, multiply, and divide decimals to hundredths. (CCSS: 5.NBT.7)
i. Use concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction. (CCSS: 5.NBT.7)

Lesson Date: 09/27/2017

Task: The central focus of this warmup is for students to solve questions about elapsed time. Once the problems are completed, students change each elapsed time into a decimal number, add up the total time, and convert their answer to a fraction.

Real-Life Connection: Understanding time is an essential part of life. Through this multilayered warmup, students learn to recognize elapsed time, and think in mod 60 when relating time to parts of a day. Specifically, the warmup asks students to figure out how long a cat sleeps a day, converting elapsed time to a fraction. Perhaps a veterinarian would need to know how long cats sleep to determine if there is a health issue or not.

Reflection: Unexpectedly, this was a very difficult warmup for students. At first, I was baffled by the whole classroom struggling. However, while being able to calculate elapsed time is an important skill, I think students generally just use their phones to figure out this type of information. This will continue to be an area I work on, but I will need to come up with a stronger real-life connection.

<u>Real-Life Perimeter and Area Warmup (10 minutes)</u>

Content Area: Mathematics
Standard: 1. Number Sense, Properties, and Operations
Grade Level Expectation: Fifth Grade
Concepts and skills students master:
4. The concepts of multiplication and division can be applied to multiply and divide fractions (CCSS: 5.NF)
Evidence Outcomes
d. Find the area of a rectangle with fractional side lengths by tiling it with unit squares of the appropriate unit fraction side lengths, and show that the area is the same as would be found by multiplying the side lengths. (CCSS: 5.NF.4b)
i. Multiply fractional side lengths to find areas of rectangles, and represent fraction products as rectangular areas. (CCSS: 5.NF.4b)

Lesson Date: 10/02/2017

Task: Students are given a figure they need to find the area and perimeter of. The shape given does not have all the sides labeled, promoting problem solving techniques.

Real-Life Connection: As is written in the problem, students are helping "Mark" find the area and perimeter of the garden he is planning to create. Students should be procedurally fluent in using equations to find the area and perimeter of shapes. However, this warmup asks students to visualize what those concepts look like physically.

Reflection: Students were immediately thrown off by how not all the sides were labeled. Some declared the problem unsolvable and mentally checked out. I taught the strategy of "using what you know", but the struggles in determining the missing side lengths really detracted from the point of the warmup. However, there was one student who persevered through the problem. I found his main issue was not being able to add up the side lengths and the areas of the different rectangles quickly enough. This brings up an interesting debate about calculators...should I have given students a calculator to help solve this problem? A calculator is only useful if one knows what numbers to plug in.

Real-Life Fractions Warmup (5 minutes)

Content Area: Mathematics
Standard: 1. Number Sense, Properties, and Operations
Grade Level Expectation: Fifth Grade
Concepts and skills students master:
2. Formulate, represent, and use algorithms to add and subtract fractions with flexibility, accuracy, and efficiency
Evidence Outcomes
a. Use equivalent fractions as a strategy to add and subtract fractions. (CCSS: 5.NF)
ii. Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions6 with like denominators. (CCSS: 5.NF.1)

Lesson Date: 10/04/2017

Task: Students are given fractions in the form of pizza pictures. Then students are asked to add each set of pizza fractions together. All answers should be represented visually.

Real-Life Connection: Fractions are easily represented as pizza slices. In addition, this visual helps students conceptually understand the concept of part versus whole. Nearly every student will have background knowledge about what half a pizza looks like, but not every student understands what ½ means.

Reflection: Procedural understanding of math facts has been drilled into students. This was especially evident when students had a hard time converting pizza images into "standard" fractions. Students had an even harder time adding pizza fractions together and visually representing them, which lets me know they understand how to add fractions on paper, but they don't understand why they are doing what they are doing.

Real-Life Algebra (5 minutes)

Content Area: Mathematics
Standard: 1. Number Sense, Properties, and Operations
Grade Level Expectation: Fifth Grade
Concepts and skills students master:
2. Formulate, represent, and use algorithms to add and subtract fractions with flexibility, accuracy, and efficiency
Evidence Outcomes
d. Write and interpret numerical expressions. (CCSS: 5.OA)
  i. Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols. (CCSS: 5.OA.1)

Lesson Date: 10/09/2017

Task: Students are given two scenarios and must match each equation with the proper problem. Then students "solve" for x with each equation, and answer each question.

Real-Life Connection: The two word problems address real-life situations the students might encounter in the real world. For example, when students are in the store, it's helpful to know how many of the same item they can buy while on a budget. Problem one of this worksheet discusses this scenario. Solving for x occurred by request of one student.

Reflection: The worksheet presented algebra problems in a way students are not used to. However, these students are familiar with the 4x3=12 relationship, so this warmup was solvable. As expected, many students expressed they hadn't seen algebra before and decided they were too confused to solve the problems. For the students who did solve the problems, their responses were more notable. One student who received both correct answers commented he didn't see the point of solving for x. Another student said he felt like he did the same thing for each problem, but couldn't explain why. Overall, these student responses reflect conceptual knowledge, which I find to be productive. These students were able to make meaning from a problem, connect to an equation, and solve the equation with their own invented strategies. This process is different than the way I was taught, but I think it promotes deeper thinking of what "x" stands for, rather than just defining the variable.

<u>Real-Life Volume (15 minutes)</u>

Content Area: Mathematics
Standard: 4. Shape, Dimension, and Geometric Relationships
Grade Level Expectation: Fifth Grade
Concepts and skills students master:
1. Properties of multiplication and addition provide the foundation for volume an attribute of solids.
b. Find volume of rectangular prisms using a variety of methods and use these techniques to solve real world and mathematical problems. (CCSS: 5.MD.5a)
ii. Apply the formulas $V = l \times w \times h$ and $V = b \times h$ for rectangular prisms to find volumes of right rectangular prisms with whole-number edge lengths. (CCSS: 5.MD.5b)

Lesson Date: 10/11/2017

Task: Students are given three different sized juice boxes to find the volume of.

Real-Life Connection: For Gracie's Specialty Juice Boxes Company, students are asked to find the volume of three juice boxes so Gracie will know how much liquid each box contains. This is a very realistic problem, as anyone who packages products needs to know how much of their product is in one portion.

Reflection: This was the best warmup I have had to date. Students were engaged with the work, understood why they were solving for volume, and knew what significance their answers had for the juice company. I will want to continue this style of warmup for my future lessons.

<u>Real-Life 3D Figures and Surface Area (10 minutes)</u>

There is no fifth-grade standard for surface area, but this class has trouble distinguishing between volume and surface area.

Lesson Date: 10/18/2017

Task: Students are given a map of a pyramid. They are asked to put together the paper pyramid, and find the surface area of it.

Real-Life Connection: Makira’s dog, Benji, wants a pyramid dog house. So, the class helped create real-life models of the pyramid her dog can sleep in. Furthermore, Makira’s dog likes to sleep on blankets, so students found the surface area of the pyramid to see how many square feet of the blanket they will need to buy.

Reflection: What a fun warmup! Students were engaged with their work, enjoyed building the model, and understood why they were finding the surface area of the pyramid. There were many exclamations of *this is fun!*

Real-Life Decimals and Combinations (10 minutes)

Content Area: Mathematics
Standard: 1. Number Sense, Properties, and Operations
Grade Level Expectation: Fifth Grade
Concepts and skills students master:
2. Formulate, represent, and use algorithms with multi-digit whole numbers and decimals with flexibility, accuracy, and efficiency.
Evidence Outcomes
c. Add, subtract, multiply, and divide decimals to hundredths. (CCSS: 5.NBT.7)
i. Use concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction. (CCSS: 5.NBT.7)

Lesson Date: 10/23/2017

Task: Students are asked to add various combinations of food prices (decimals) together. All totals should be less than $5.

Real-Life Connection: When eating on a tight budget, it makes sense to buy as much food as possible without going over the budget amount. This is the situation the character in the story problem is in, and students add together combinations of food items to total less than $5.

Reflection: This was an interesting warmup. All students knew what they were asked to do and why, but many students found the repetition of adding decimals to be “torture”. Even though every aspect of this warmup had real-life applications integrated, this warmup definitely didn’t generate positive student attitudes.

Real-Life Division (10 minutes)

Content Area: Mathematics
Standard: 1. Number Sense, Properties, and Operations
Grade Level Expectation: Fifth Grade
Concepts and skills students master:
4. The concepts of multiplication and division can be applied to multiply and divide fractions.
Evidence Outcomes
b. Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers.

Lesson Date: 10/30/2017

Task: Students are asked to solve a variety of division word problems.

Real-Life Connections: Each word problem has a real-life situation.

Reflection: Most student feedback revolved around the word “fun”. Many students enjoyed this warmup and said it wasn’t too easy and wasn’t too hard. There was an awesome whole class discussion about what to do with remainders in the real-life context of each problem. Engaging in productive discussion was the highlight of this warmup.

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