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Mathematics Value Research

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Abstract

Recent research shows how significant experiential learning can be to teaching the critical application of math to real-world problems. However, there is still a lack of research regarding experiential learning and its application to real-world problems regarding the concept of value. Concepts such as value are necessary for money management to help people maximize their purchase of goods and services. Currently, math classrooms teach procedural problem-solving, which may leave students unable to apply math critically to value-related math problems. This research examined critical thinking skills through completion of a real-world question about value before and after an experiential learning activity and use a perception survey to understand if applying math changes a student's confidence about doing math. This research provides important insight into whether students would benefit from a hands-on learning approach using actual real-world scenarios to apply critical thinking to their everyday experiences.

Introduction

Students in the United States public schools should have basic proficiency in applying mathematics in real-world situations. However, many high school students cannot critically apply math, such as one-step equations and proportions, to real-world situations encountered in everyday life (Ambrus et al., 2019). As a result, students may be unprepared to manage their finances and perform many necessary life skills, such as determining consumer value. Currently, educators often teach math as an abstraction to solve specific problems with an algorithm or set of steps, which may not translate well to real world problem solving. Some current literature supports the use of hands-on learning, such as manipulatives, to teach critical thinking skills and aid in the application of abstract concepts to real-world situations (Althauser & Harter, 2016; Benson-O'Connor et al., 2019). For this study, I researched the effectiveness of teaching math problem solving abilities through real-world activities and its effect on math confidence in high school math students. Since this research involves working with a population of children, my experience, which involves teaching in a public school of the middle and high school level, helped me to implement an activity that posed minimal risk. My research question was as follows: How does experiential learning change student confidence, perception, and ability to solve real-world math problems?

The field of education can benefit from research that evaluates teaching methods that can enhance real-world problem solving and improving student confidence. I believe this topic is essential because, in prior experiences, students do not understand the difference in the value between buying the snacks from a vending machine and buying the snacks from a grocery store. The students knew the vending machine snacks cost less, but they did not understand the value, or per-unit cost may be less at the grocery store or in larger package sizes. While this is just one example, there are many instances for which understanding value will allow students to learn to get more for their money and be able to purchase more goods and services.

I investigated the application of linear proportions to the concept of value in a three-step process. First, I began with a survey to evaluate attitudes, perceived proficiency, and a value word problem, asking whether

buying a small package of crackers at a specific price is a better value than buying a larger box of crackers at another price. Students determined the linear proportion of cost versus quantity with two different package sizes of a consumer product. If one unit increased by consistent increments, in this case, number of items, then cost increased by a constant proportional amount. Students related these findings based on initial package size. Students began with two package sizes of an identical product and count the contents. Each student defined a base amount of product, for example, 30 or 10 crackers, and determined the cost-per-unit for each quantity. After completing the action portion of the experiment, students completed a second survey to assess changes in attitude,perceived proficiency, or ability to evaluate the value word problem. The goal of my study was to evaluate the perception of student skill and math confidence and to assess the effectiveness of action based experiential learning on the application of mathematics to real world situations. This research helps to determine the best methods for teaching real world application of math concepts.

Literature Review

Teacher's Views of Real-World Teaching

Olabe et al. (2014) conducted a study to determine whether student teachers agree that educators should teach mathematics with two types of problems. The first type of math problem, type A, corresponds with teaching math with a determined solution where only one answer is correct. The second type of problem, type B, consists of problems with more than one correct answer and multiple possible approaches for solutions. Survey results indicated that over 90 percent of the student teachers agree that students should solve both type A and type B math problems at the secondary level (p. 81). Respondents agreed that both types of problems exist in everyday life, and students would benefit fromeach since both types requires different cognitive processing. The results imply that most teachers agree that giving students open-ended, real-world math problems can improve students' cognitive processes (p. 81).

Benson-O'Connor et al. (2019) used math journals to evaluate students' understanding of math concepts and math applications to real-world problems. The method of the study was twofold. First, students

kept one personal math journal describing their math struggles, and one classroom shared a math journal giving real-world examples of mathematical applications. Secondly, students answer questionnaires to measure their self-efficacy at the beginning and the end of the study. This study shows evidence that journaling helps students make a metacognitive connection to applying math to real- world applications. Benson-O'Connor et al. (2019) conclude that students, who can identify and solve real world examples, have a better understanding of mathematical concepts (pp. 16-18).

Mark Jelinek (2015) gave a comprehensive review of the skill sets required to solve real-world math problems. He asserts that teachers need to design problems with sufficient complexity to both teach and assess metacognitive understanding (pp. 15-16). His reflections note that in many educational settings, teachers reward students for identifying a type of problem, applying the appropriate steps to a solution,and determining the correct answer. Instead, teachers should reward students for performing critical analysis and taking logical steps to determine a possible realistic solution. The emphasis on the importance of translating math concepts to real-world solutions supports the view that teachers should use real-world problems designed to mirror problems found in the real-world and engage students in critical analysis.

Vos (2018), Department of Mathematical Sciences, University of Agder, defines the word *authenticity* concerning real-world mathematics teaching. She asserts that for a math problem to be authentic, it must meet two criteria, which are that the problem must have an out-of-school origin and that an expert in the field of the chosen problem must certify that the problem is authentic, that is, that the problem has real-world significance. She further explains that students are more motivated and engaged by genuine real-world math problems. She concludes that when teachers use real-world approaches, it may be necessary to authenticate the realness of a proposed classroom assignment (pp. 11-12).

Teaching with Manipulatives and Activities

Buchheister et al. (2017) explain that teaching math through math games while using the Universal Design for Learning results in improving students' reasoning and problem-solving skills while allowing

differentiation (p. 12). Universal Design for Learning has three key facets: multiple modes of presentation, expression, and engagement. Cards present the information both numerically and pictorially. The gameplay encourages students to use multiple modes of expression because there are different strategies for finding and comparing the totals for every round played. Teachers can easily modify the game to allow for multiple means of engagement, or differentiation, requiring some students to only compare single-digit numbers without adding, or having other children add three numbers before comparing totals. Instead of having a worksheet with fixed equations, teachers modify games during classroom time according to each child's formatively assessed ability and interest. By playing games in groups, students learn to communicate in mathematical terms and to agree on one correct answer to determine the winner. Throughout the games, each student plans their strategies which builds reasoning and problem-solving skills.

Althauser and Harter (2016) show the effectiveness of learning economics and applied math using real-world integration of concepts through community partnerships with small local businesses. After teachers completed required training with local community business partnerships in the subject ofinterest, economics, teachers chose curricula in finance that aligned with their grade level. Students performed a pretest and a post-test to assess their proficiency in both math and economics. The results show statistically significant improvement in the grade 3 through 5 students' math problem-solving proficiency, supporting the effectiveness of teaching with authentic real-world math (pp. 115-118).

Arican (2019) investigated pre-service teachers' ability to determine proportional and inversely proportional relationships using hands-on activities and real-world word problems. Determining proportions is a critical topic that research has identified as an area with numerous educational difficulties. The data from the hands-on problem activities showed that the pre-service teachers qualitatively understood direct proportions, and to a lesser degree, inverse proportions. The real-worlddata with missing value word problems shows that pre-service teachers can master both the qualitative and quantitative concepts of both direct and inverse proportions. Arican (2019) supports theeffectiveness of using manipulatives and real-world mathematical

applications.

Kokko et al. (2015), researchers from the University of Finland and the University of Helsinki, Finland, collected interview data from students to determine the efficacy of teaching mathematics through application to technology such as wind turbines, hybrid pedal cars, and motors. The study's outcome showed improved attitudes and understanding of mathematics as applied to technology and design (T and D) (pp. 27-29). Some researchers noted that the studies should explore mathematics as applied to multidisciplinary subjects and that limiting the scope to T and D shows a preference for STEM students. The study did use "authentic" real-world problems as defined by Vos (2018). To reach all students, further studies should include a multidisciplinary design, such as economics in Althauser and Harter (2016).

According to Suarez-Gomez and Perez-Holguin (2020), having hands-on tools to teach math concepts, specifically matrix math, improves the development of complex mathematical concepts forthe learner. Previous studies show that using LEGO Mindstorms is an effective teaching tool to teach basic principles for science, engineering, computation, and physics to K-12 learners. Here, the researcher tests the hypothesis for graduate level-students learning advanced series and sequences using a post-exercise survey. Suarez-Gomez and Perez-Holguin (2020) conclude that all student levelsimprove in metacognitive understanding and application of math concepts (p. 85). The data supports my research problem indicating that real-world teaching leads to improvements in applying math to multidisciplinary scenarios.

Real-World Problems and Cognitive Reasoning

Brito et al. (2020) present an overview of the types of reasoning skills necessary for learning mathematics and emphasizes the importance of fostering specific types of cognitive skills rather than teaching rote memorization of problem-solving algorithms. She identified two skills for improving mathematical ability: working memory and fluid reasoning. Working memory allows the student to keeppieces of information in short-term memory to explore connections between different facts. Fluid reasoning is the exploration of relationships between facts and consists of both deductive and inductivereasoning. Students should learn to

develop an understanding of a situation or concept by connecting with prior knowledge and moving towards the abstract and ambiguous nature of problem- solving. Teachers should emphasize developing thinking skills by modifying teaching methods to support deeperthinking and problem-solving. Brito et al. (2020) emphasize the importance of teaching towards an improved goal, which promotes thinking skills and reasoning rather than the rote application of algorithms (pp. 3-7).

Su et al. (2016) assert that teachers can use alternative teaching methods for teaching mathematics to enhance critical thinking skills. Using Bloom's Taxonomy, teachers impart knowledge, comprehension, application, analysis, synthesis, and evaluation towards a higher level of thinking. By creating critical thinking skills, students can find the necessary information needed, process information in a logical manner, and prepare themselves for self-directed learning. The teachers' role is to focus on critical thinking skills rather than teaching the standard algorithm. In this case, the method chosen to research alternative instruction was multiplication as a sum of squares using single-digit and multiple-digit factors. The conclusion of the authors (2016) supports teaching critical thinking skills to reason through problem-solving even at the rudimentary level of multiplication (p. 199). The authors suggest further research to determine whether students' progress by grade level in their ability to solve a particular word problem and whether students become more able to formulate additional interpretive solutions to a word problem.

In Ambrus et al. (2019), the authors explore the question of whether students do progress by grade level in their ability to solve word problems. The study measured student ability using a numerical analysis based on whether there was no answer, the expected answer, a computational error, a miscellaneous answer, or a realistic answer. Students, grades 2 to 10, develop their ability to solve a word problem with one expected answer. Students do not improve in their ability to give multiple, morebroadly realistic interpretive answers. The conclusion suggests that students cannot apply skills to createmultiple logical solutions to a real-world math problem.

Conclusion

The literature review shows the importance of using alternative methods for teaching mathematics. Teachers agree that students learn best when taught using real-world math problems (Benson-O'Connor et al, 2019; Olabe et al., 2014). Alternative methods encourage open-ended thinking processes and logic to explore and consider many possible strategies and solutions to givenproblems (Buchheister et al., 2017). Focus on real-world applications gives students a concrete understanding of abstract concepts like proportions and fosters confidence and reasoning skills (Althauser & Harter, 2016; Kokko et al.,2015). In general, they found that students can understand math concepts at a deeper level using a real-world focus (Brito et al., 2020; Su et al., 2016).

A plethora of research demonstrates the importance of using manipulatives for teaching critical math thinking skills. These studies show students improve their reasoning skills while using real-world applications (Ambrus et al., 2019). However, there is a lack of research to show that teaching with real-world problems will improve reasoning skills that students can apply to unfamiliar topics such as value.

Research Methods

Research Question

After examining the literature on teaching mathematics using real-world math problems, I have formed the following research question to investigate for my EDCI 590 research project: How does experiential learning change student confidence, perception, and ability to solve real-world math problems?

Participants and Settings

The participants for this study have been recruited from a high school in Northern Virginia. After review of the detailed methodology based on action learning strategies by Goodchild & English (2002), permission was granted to work with the mathematics department at this school. The participants were 23 male/female students in a mathematics class currently in grades 10-12. Participants completed informed consent and assent forms prior to the study (See Appendix A, B). Students who choose not to take part in my study did not have any adverse impact in their regular classroom and were able to complete the learning activity along with the students participating in the study, but I did not use any data about them in my study. Since student participants

took the survey in class and completed the hands-on activity individually and silently at their desks, they were not in a private, but rather in a semi-private environment.

Intervention

After parental consent and student assent forms were signed, students received a packet that contained a preassessment survey and question, an activity, and a post assessment question and survey (See Appendix C, D, E). The pre and post assessments were identical. Modeling the methodology of Benson-O'Connor et al. (2019) and Suarez-Gomez & Perez- Holguin (2020), the surveys had a numerical score to assess student confidence in math. The survey was only offered in written form. Students evaluated and rated their agreement with the statements using a 5-point Likert format: "Strongly Disagree", "Disagree", "Neutral", "Agree", and "Strongly Agree". The student received maximum points for a question (4 or 5 points) if their answer was consistent with the positive result (more confidence/better perception), and less points (1 or 2 points) if their answer was more negative (worse confidence/worse perception). If the student responded neutrally, they received 3 points for that question. Students also independently completed the real-world word problem that asks them to determine, abstractly, the price per unit, in this case a cracker, and then determine value.

Using activity methodology similar to Suarez-Gomez & Perez-Holguin (2020), students completed an experiential real-world learning activity. Each student received two packages of cardboard crackers, one representing a single serving pack from a convenience store and the other representing one multipack from a grocery store, and paper coin money. Students counted the crackers in each package and determine the per cracker cost using paper money. After completing the activity, students took the post assessment to reassess student confidence in math. Each student answered the same post activity survey questions again using a one-to-five-point scale and the identical word problem about cost and value. The packets were collected at the end of the period upon their completion.

Data Collection

When giving out the packets, the students were instructed not to share their answers with anyone, and

that I will not share any of their responses to anyone else. Although I knew which students had consent and assent to take the survey and which did not, I was not able to associate any survey responses to individual students either directly or indirectly. After participants completed their packets, I evaluated and scored the surveys and pre and post assessment and entered the data on my personal password-protected computer. In any reports I made about this study, I did not use the child's name or any other information that could be used to identify him or her directly or indirectly. Since my study is completed, I destroyed all the information I collected that identifies individual students.

Data Analysis

The surveys yielded scores that are an overall score for each student showing confidence and perceptions levels. After averaging the scores, I made a statistical comparison of the before and after data using the standard SPSS software. I also scored the word problem on a scale from 0 to 10, both before and after the activity using predetermined rubrics. A statistical T-test was used to determine whether the results for the survey showed statistical significance and a Wilcoxon Signed Ranks Test was used to evaluate the pre and post problem.

Results

Descriptive Statistics

Table 1: Descriptive statistics for the confidence pre-post survey and pre-post problem.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Pre-Confidence	23	68	127	97.30	14.674	215.312
Post-Confidence	23	68	132	97.17	15.005	225.150
Pre-Problem	23	0	10	9.35	2.288	5.237
Post-problem	23	10	10	10.00	.000	.000
Valid N (listwise)	23					

Statistical Tests

Once the math confidence and perception surveys were scored, the data was tested for normality. We

failed to reject the null hypothesis, meaning that the data was not different than normal (Shapiro-Wilk = 0.964, DF= 23, P = 0.54). Because the data was normally distributed, we ran a t-test to compare the mean pre-survey score with the post survey score. The results were that we failed to reject the null hypothesis, meaning that the pre-scores were not significantly different than the post-survey scores (T-test = .166, DF= 23, P = 0.87). For the pre and post question, the data was tested for normality. We rejected the null hypothesis, meaning the data was not normally distributed (Shapiro-Wilk = 0.324, DF= 23, P < 0.001). Because the data was not normally distributed, we ran a Wilcoxon Signed Ranks Test. We failed to reject the null hypothesis, meaning the pre-problem was not significantly different from the post-activity problem (Z= -1.342, P=0.18).

Discussion/Conclusion

In this paper, we were looking at whether experiential learning changes student confidence, perception, and ability to solve real-world math problems. Our findings shows that the pre-survey scores (refer to table 1) were not significantly different than the post-survey scores (P > 0.05), and problem-solving ability of the students did not change significantly (P> 0.05). These results may suggest that this specific hands-on activity of counting real objects does not translate to increased ability to problem solve a real-world math problem related to value or increased confidence in the students. This is contrary to past studies which looked at experimental learning as a way to teach math as it applies to real world situations (Althauser & Harter, 2016; Benson-O'Connor et al., 2019).

Reasons for this result may have to do with the limitations of the study. The student population studied were higher level math students, many of whom were able to complete the math problem correctly before the hands-on activity. This indicates a more difficult problem may have been beneficial to see progress in learning, and a change in confidence. Also, if students indicated neutral confidence, the expected mean would be 93. Since the survey means were near neutral, confidence means of 97.3 and 97.17, these students, although proficient in the math problem given, indicated a neutral confidence towards math. More research would be needed to evaluate student confidence in solving math problems relative to their demonstrated proficiency. The

field of education would also benefit from additional studies that use hands on activities based on students' zone of proximal development, rather than an area in which the students are already proficient, to better understand the use of hands-on related activities and its effect of student math solving proficiency and confidence.

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Appendix A

PARENTAL INFORMED CONSENT FORM

Brief Description of Research Study

The purpose of the research described below is to investigate if hands on learning improves student confidence and improves student's ability to solve math problems related to the concept of value in everyday life situations. During this study, children will receive their normal mathematics instruction. The only difference will be that students will be given a packet to complete during the regular school day that contains a pre assessment survey and math problem, a self-directed activity, and a post assessment survey and math problem. Once the packets are completed, I will collect all the packets and analyze the data to measure the amount of improvement in math confidence and math problems solving skills as applied to a real-world situation. The risks to children in this study are minimal, but the benefits could be improved confidence and math problem solving skills. **Please read the rest of this form before deciding if youwill allow your child to be in this research study.**

My name is Diane LaMoy and I am a student at the University of Mary Washington and a prior long term substitute mathematics teacher at KGHS. Because you are the parent or legally authorized representative of a child in a mathematics classroom, I am seeking your permission to let your child participate in this research study. Involvement in the study is voluntary, so you may decide whether to let your child participate or not. I will also ask your child if he or she wants to be in the study, and I will only collect information if both you and your child agree. Before making your decision, please read the information below and ask me any questions that you have about the research; I will be happy to explain anything in greater detail.

Details of the Child's Involvement

In your child's mathematics class, I will pass out my research packet. Students will complete the packet if they choose to be part of the study. The packet should take approximately 60 minutes to complete and could be completed during their I/E period, but the packet may not leave the classroom. Students will sit at

their desks and complete the packet, beginning with the pre assessment survey and math problem. The pre assessment will ask the students about their confidence about math, on a scale of 1 to 5-points whether they "Strongly Disagree", "Disagree", "Neutral", "Agree", and "Strongly Agree". Then, students will use the manipulatives provided with the packet to work through a learning activity for which the students will count objects and determine the price per object. After completing the learning activity, students will fill out the same survey for post assessment and resolve the same math problem. Even if your child does not take part in my study, he or she will not have any adverse impact in their regular classroom and may complete the learning activity along with the other students, but I will not use any data about them in my study.

Privacy and Confidentiality

This study will take place while children are in their classroom, so they will have semi-privacy while completing the packet. However, to ensure confidentiality I will not reveal any private information about your child to anyone, unless required by law to do so. No one but me will be allowed to see the packets completed by your child. In any reports I make about this study, I will not use your child's name or any other information that could be used to identify him or her directly or indirectly. When my study is complete, I will destroy all the information I collected that identifies individual students.

Risks and Benefits of Participation

Completing the surveys, math problem, and activity contained in the packet poses minimal risk to your child, however, some students may feel some anxiety if they normally experience anxiety while practicing math, answering mathematics related questions, or completing a survey. There are no rewards for students who take part in this study, and no penalties of any kind if they do not take part. However, being in this research study might improve student confidence towards performing mathematics related tasks and their ability to apply math to everyday real world situations involving math. If the results of this study show a positive impact on children's confidence and problem-solving ability, it could improve education for more children in the future.

Participant Rights

You have the right to ask any questions you have before, during or after the study, and I encourage you to do so. If you do not want your child to be in this study, there will be no penalties or loss of benefits that he or she is entitled to. If you agree to let your child, be in this study and later change your mind, you have the right to take him or her out simply by contacting me at the email address below, and I will destroy any research data collected about your child. This research has been approved by the University of Mary Washington Institutional Review Board, a committee responsible for ensuring that the safety and rights of research participants areprotected. For information about your and your child's rights regarding this research, contact the IRB chair, Dr. Rosalyn Cooperman (rcooperm@umw.edu).

Contact Information

For more information about this research before, during or after your participation, pleasecontact me (dlamoy2@mail.umw.edu) or my university supervisor, Dr. Patricia Reynolds (preynold@umw.edu). To report any unanticipated problems relating to the research that your child experiences during or following participation, contact my university supervisor, Dr. Patricia Reynolds (preynold@umw.edu). Please return this form to me by November 19, 2021. Before signing this form, please ask me any questions you have about participation in this study.

To be Completed by Participant

I have read all of the information on this form, and all of my questions and concerns about theresearch described above have been addressed. I choose, voluntarily, to permit my child to take part in this research study. I certify that I am at least 18 years of age.

_____

Print name of child

_____

Print name of parent or legally authorized representative

_____ _____

Signature of parent or legally authorized representative. Date

To be completed by Researcher

I confirm that the legally authorized representative of the child named above has been given an opportunity to ask questions about the study, and all the questions asked have been answered tothe best of my knowledge and ability. A copy of this Consent Form has been provided to the child's legally authorized representative, and I will keep the original for a minimum of three years.

_____

Print name of researcher

_____ _____

Signature of researcher Date

Appendix B

CHILD ASSENT FORM

Dear Student,

My name is Diane LaMoy and the reason for this letter is to ask if you want to be in a research study I am doing. By "research" I mean that I am trying to find out more about something. In this study I am trying to find out more about how students feel about math and whether having objects to count and look at helps students feel more confident about math and helps them to be able to apply math in everyday life situations.

I have already asked your parent or guardian if they will permit you to be in this study. If they did not agree, you will not be asked to sign this form. If they did agree, it is still your choice to make, and I am now going to describe what you will do if you agree to be in this study. Even if you or your parents do not want to be in the study, you will still participate in the lesson, but I will not use the data. I am going to read this information to you, so listen carefully and ask any questions you have before you decide whether to be in the study or not.

What will you do if you are in this study?

You will complete a packet in your classroom. In this packet, all students will complete a written survey, math problem, and mathematics activity related to counting objects and figuring out how much items cost. If you agree to be in my study, you will do the same work in the packet as other students and be assessed the same way. At the beginning of the packet, all the students will take a survey about how confident they are with math. Then, students will solve a short math word problem. Next, students will perform an activity counting cardboard objects, and perform some math calculations using multiplication and division. At the end of the packet, all students will retake the same survey and solve the same math problem. If you agree to be in my study, I will tally your survey and math problem scores to use in my research study. Also, ifyou decide to be in my study, I will not use any identifying information about you in my study.

What will you do if you are not in this study?

Nothing bad will happen to you if you do not want to be in the study, and it will not hurt your grade in the class. You will still do your normal math class activities. Also, if you are not in the study, I will not record any information about you for my research.

Will anything bad happen to you in this study?

If you decide to be in this study, you will have to complete the packet, which may take up to 30 minutes of your time. Some students may feel some anxiety answering the survey questions, completing the math problem, or performing the math activity; however, you do not have to answer any questions that youdo not want to answer. I will also make sure that you do not miss any of your regular math instruction.

Will anything good happen to you in this study?

You will not receive any special rewards for agreeing to be in this study. In other research studies like this, some students gained more confidence in their problem solving and did better in class because they used hands on learning to work out mathematical concepts, and this might or might not happen for you.

Will anyone else know what you do or say in this study?

In my study, I will not use the names of any students. If you decide to be in this study, I will not tell anyone else about what your answers are in the packet or show anyone else your packet unless Imust for legal reasons.

What if you have any questions?

Be sure to ask me any questions you have before deciding whether to be in this study or not. Even if you don't have questions now, you can ask me about this study at any time later. If you would like time to discuss it with your parents before making your decision, please tell me.

What if you change your mind?

If you decide to be in this study and later change your mind, just tell me that you want to stop. I will stop collecting information about you for my study and will take out all of the information I already have about

you. I will finish my study on November 30, 2021, so that is the deadline when you should tell me if you want your information taken out of the study.

_____

Print name of researcher

_____ _____

Signature of researcher Date

To the Student: Your signature below indicates that you have read the information on this form or that I have read the information on this form aloud to you, and that all of your questions about this research study have been answered.

Please put an X next to your decision:

_____I agree to take part in this research, complete the packet, and share my completed packet with theresearcher

_____I DO NOT want to have any information about me used in this research

_____

Print name of student

_____ _____

Signature of student Date

Appendix C

Pre and Post Assessment Survey

This is a survey of your attitudes and perceptions about math; these statements all have the response choices Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree, and should take less than10 minutes. Please choose the response that matches your opinion, not what you think an instructor or researcher might say or want to hear.

1. After I study a topic in math and feel that I understand it, I have difficulty solving problems on the sametopic.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

2. There is usually only one correct approach to solving a math problem.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

3. I am satisfied if I can do the exercises for a math topic, even if I do not understand how everything works.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

4. I do not expect formulas to help my understanding of mathematical ideas, they are just for doingcalculations.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

5. Math ability is something about a person that cannot be changed very much.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

6. Nearly everyone is capable of understanding math if they work at it.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

7. Understanding math means being able to recall something you have read or been shown.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

8. If I am stuck on a math problem for more than ten minutes, I give up or get help from someone else.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

9. I expect the answers to math problems to be numbers.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

10. If I do not remember a particular formula needed to solve a problem on a math exam, there's nothingmuch I can do to come up with it.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

11. In math, it is important for me to make sense out of formulas and procedures before I use them.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

12. I enjoy solving math problems.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

13. Learning math changes my ideas about how the world works.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

14. I often have difficulty organizing my thoughts during a math test.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

15. Reasoning skills used to understand math can be helpful to me in my everyday life.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

16. To learn math, the best approach for me is to memorize solutions to sample problems.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

17. No matter how much I prepare, I am still not confident when taking math tests.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

18. It is a waste of time to understand where math formulas come from.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

19. We use this statement to discard the survey of people who are not reading the questions. Please selectAgree (not Strongly Agree) for this question. (Filter statement; discard data for respondents that do not choose Agree here.)

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

20. I can usually figure out a way to solve math problems.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

21. School mathematics has little to do with what I experience in the real world.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

22. Being good at math requires natural (i.e. innate, inborn) intelligence in math.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

23. When I am solving a math problem, if I can see a formula that applies then I don't worry about theunderlying concepts.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

24. If I get stuck on a math problem, there is no chance that I will figure it out on my own.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

25. When learning something new in math, I relate it to what I already know rather than just memorizing itthe way it is presented.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

26. I avoid solving math problems when possible.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

27. I think it is unfair to expect me to solve a math problem that is not similar to any example in class or thetextbook, even if the topic has been covered in the course.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

28. All I need to solve a math problem is to have the necessary formulas.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

29. I get upset easily when I am stuck on a math problem.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

30. Showing intermediate steps for a math problem is not important as long as I can find the correct answer.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

31. For each person, there are math concepts that they would never be able to understand, even if theytried.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

32. I only learn math when it is required.

◯ Strongly Agree

◯ Agree

◯ Neutral

◯ Disagree

◯ Strongly Disagree

Appendix D

Pre and Post Assessment Question

Please read the following question.

Question: Is one package of 6 crackers for $1.50 or 3 packages of 6 crackers for $2.70 a better value? Hint:find the price per cracker.

Please use the space given below to answer this word question:

Appendix E

Hands on Activity:

1. Find 2 envelopes labeled A and B

2. Each envelope has a price on it and a representative amount of paper coins

3. Open A and remove 1 pack of cardboard crackers bought as a single pack from a vending machine and thepaper coins

4. Count the crackers

5. Using the paper coins provided, divide the total price of packet A by the number of crackers in package A tofind price per cracker.

6. Determine the equation for the total price of any number of crackers as a function of X:

TP(X) = price percracker * X (number of crackers)

7. Open packet B. Remove 3 packs of cardboard crackers bought in a single pack from a grocery store and thepaper coins

8. Find the total number of crackers by counting the crackers

9. Using the paper coins provided, divide the total price listed on Envelope B by the total number

of crackers inenvelope B

10. Determine the equation for the total price of any number of crackers as a function of X, TP (X) = price percracker * X (number of crackers)

11. You should have 2, single step algebraic equations A which gives the price per cracker from a vendingmachine and B which gives the price per cracker from grocery store.'

12. How much is one cracker for A and B?

13. Which cracker costs less?

14. Which cracker is a better value?