

## ABSTRACT

HOLLAND, LINDSAY ANNE. Initial Instruction in a Mathematics Classroom: Learning in a Contextual Setting. (Under the direction of Dr. Karen Allen Keene.)

The purpose of this research was to investigate how the order of mathematical instruction with respect to using a context affects students' performance in the classroom and their attitudes towards learning. The study examined two high school Algebra I classes and was implemented over three days. On Day 1 of the study, the experimental group received the implementation of learning in a contextual setting while the control group learned in a noncontextual setting. In the noncontextual setting, students learned about one and two step equations where a lecture style lesson was implemented. On Day 2 of the study, each of the two groups received the type of instruction the other group received on Day 1. The experimental group received the traditional approach method where the control group learned the mathematics in a contextual setting. The study determined that there is a difference in students' academic performance when they learn in a contextual setting first and then learn the math in a traditional based approach as opposed to learning in a traditional setting first and then learn in a contextual setting. Students' attitudes toward learning in a contextual setting without regards to order were more positive. Finally, the order of instruction with respect to using a context affects lower ranked students' levels of performance in the classroom more than middle or higher ranked students, but not significantly more.

# Initial Instruction in a Mathematics Classroom: Learning in a Contextual Setting

by  
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## DEDICATION

To my mom and dad who gave me constant and unconditional love and support throughout this rewarding experience.

## BIOGRAPHY

Lindsay Anne Holland was born February 20, 1985 in Forsyth County, North Carolina. She is the daughter of Al and Sherry Holland and was born and raised in a small town called High Point, North Carolina where she attended Ledford Senior High School. Lindsay graduated high school with honors in May 2003 and began her collegiate career in August 2003 at North Carolina State University in Raleigh North Carolina.

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## CHAPTER 1

### INTRODUCTION

The National Council of Teachers of Mathematics (2000) promotes the instructional strategy of placing mathematical instruction in a contextualized setting, stating that students as early as grades 6-8 should be able to “model and solve contextualized problems using various representations, such as graphs, tables and equations” (p. 222). The concept of learning in a contextual setting allows students to take a math topic and relate it to a real life situation. In a study that Alsina (2007) reported, she referred to the term “real world” as “everything that has to do with nature, society or culture, including everyday life as well as school and university subjects or scientific and scholarly disciplines different from mathematics” (p. 35). Alsup and Sprigler (2003) argue that, “Prominent organizations such as the National Council of Teachers of Mathematics and the National Research Council have identified aspects of mathematics classroom instruction that must be changed to improve mathematics instruction and increase student achievement” (p. 689). They contend that stronger connections between mathematics and students’ lives outside the classroom need to be made and teachers need to redirect their teaching focus by discarding the traditional lecture based approach and follow a different approach where students can construct their own knowledge (Alsup & Sprigler, 2003).

It is important that students are able to connect to the mathematics they are being taught and can make relationships with the math with real life situations. There are several reasons why learning in a contextual setting is being used and studied. Three, but not necessarily all, of these reasons are that 1) this learning context motivates students

(Gravemeijer & Doorman, 1999), 2) makes the math realistic (Hough and Gough 2002, Heuvel-Panhuizen 2007) , and 3) provides ways for the math to be more meaningful to the students (Wubbels, Korthagen, and Broekman 1997, Sullivan, Zevenbergen, and Mousley, 2003).

When students learn in a contextual setting, they become more motivated to learn because they are able to relate more personally to the math. A constant struggle that teachers have in their classroom is motivating students to learn. During a traditional lecture teaching approach, students seem to become restless and disinterested in the lesson. While in this type of instruction, students are expected to memorize procedures and facts. This type of instruction can hinder students' motivation towards learning the math. However, learning in a contextual setting allows for students to use real world examples to understand different math topics. Gravemeijer and Doorman (1999) explain that context problems are starting to play a more central role in the curriculum because of their "presumed motivational power" (p. 111). The realistic settings that come from the contexts promote this motivation.

Using real world examples is thought to present mathematics as a means with which to understand reality. (Boaler, 1993). Boaler (1993) explains that setting a task in real context can guide students to an understanding that mathematics may be used to "transform reality" (p. 12). This perspective shows students how math is involved in the real world which is known to motivate and engage students. When students are involved in something that they can relate to, they are going to become more engaged in the material because they enjoy the context the math is being placed in. Motivating students to get involved in the classroom can be a difficult task for teachers because of the type of instruction that they use

consistently. Alsina (2003) explains that the classic way of delivering lectures needs to change. She states: “Find a task that promotes students to see the reality in mathematics and this will increase their motivation in the classroom.” (p. 35).

Learning in a contextual setting allows students to work on math problems that give relevance to the real world. This allows students to work with realistic math situations in which they are able to relate to outside the mathematics classroom. This type of learning is called Realistic Mathematics Education. Hough and Gough (2007) state this curriculum “uses imaginable contexts to help pupils to develop mathematically, with a strong emphasis on pupils ‘making sense’ of the subject” (p. 34). When students are using this type of curriculum, they are able to learn the math in a realistic context which allows them to connect the mathematics to reality. When connecting the mathematics to the real world, students are also able to imagine the mathematics. Heuvel-Panhuizen (2002) states that Realistic Mathematics Education provides an “offering the students problem situations which they can imagine” (p. 3). In other words when students imagine the mathematics involved, they are able to envision something real in their minds that connect to the mathematics. Students are able to connect to the mathematics when learning in a contextualized setting because the math is created to be a realistic situation that they can relate to as well as imagine.

Thirdly, when students are able to take the math and apply it to realistic situations, they are allowing for the mathematics to take on a more meaningful role because of their ability to connect to the mathematics. Traditionally, when students are taught mathematics, they are constantly learning about new formulas, rules, and basic facts and most of the time

have to memorize them. According to Wubbels, Korthagen, and Broekman (1997), the mechanistic point of view of mathematics is about the system of rules and algorithms where much attention is paid to “a careful stepwise approach, memorizing, and learning the ‘tricks’” (p. 1). This statement emphasizes the issue that students are too busy memorizing math facts and are not able to see the true meaning behind the math. However, learning in a contextual setting allows for the mathematics to be more meaningful. Mathematics teachers are encouraged to use realistic contexts in their teaching because it makes the mathematics more meaningful (Sullivan, Zevenbergen, & Mousley, 2003). The frequent use of using contextual problems in the mathematics classrooms enables the math to possess a more meaningful role to the student because of the realistic nature they promote. Sullivan, Zevenbergen, & Mousley (2003) state that “Contexts are now used frequently in mathematics classrooms in order to make concepts and operations more meaningful as well as to show the usefulness of specific ideas and skills being studied (p. 107).

In this study, I examine how learning in a contextual setting affects both students’ academic performance and their attitudes. Clearly, there are good reasons to use context when teaching mathematics. In this study, I extended the issue of context in a new way that has not been investigated before but is embedded in the earlier research. My research questions concern the order of the instruction. When one group of students was learning in context, they learned the mathematics first through a realistic activity that they could relate to and imagine experiencing on a typical Friday night. They then were instructed about the same material in a traditional way. When the other class of students was receiving instruction, they listened to a traditional lecture and then participated in a day of learning in

context. Thus this research investigated a few days in the mathematical instruction of students who were involved in two different types of instruction taught in different order and building on the three reasons listed above: motivation, relating to the mathematics, and making mathematics meaningful. The research questions for this study are:

1. How does the order of instruction, learning in context before or after traditional instruction, affect students' level of academic performance and their attitudes toward learning?
2. How does the order of instruction, learning in context before or after traditional instruction, affect different levels of academically ranked students' level of academic performance?

## CHAPTER 2

### LITERATURE REVIEW

One of the more common teaching styles today is a traditional teaching approach where teachers use a lecture based setting in their classrooms. Student learning is more focused on learning and memorizing basic math skills and concepts where little emphasis is placed on relating these to situations outside the classroom. Some researchers say that the instruction in our nations' schools has been unsuccessful in promoting conceptual understanding and application of mathematics to real-life contexts (Alsup & Sprigler, 2003). In a traditional teaching approach, students take notes, listen to the lecture, do examples, and at the end of the lesson they may be exposed to a couple of word problems that involve a real life situation. These word problems are intended to help students see how the mathematics is applied outside the classroom and how they can relate to it as well. When students are learning math through this perspective, one might say they are doing math in a contextual setting. Researchers define context problems as "problems of which the problem situation is experientially real to the student" (Gravemeijer & Doorman, 1999, p. 111).

I conducted a study to determine if the order of instruction, learning in context before or after traditional instruction, affects students' level of academic performance and their attitudes toward learning. In this chapter, I discuss research that supports and connects to this study. Previously discussed were three motives for using contextual settings in the classroom. These motives include 1) this learning context motivates students (Gravemeijer & Doorman, 1999), 2) makes the math realistic (Hough & Gough 2002, Heuvel-Panhuizen 2007), and 3) provides ways for the math to be more meaningful to the students (Wubbels,

Korthagen, & Broekman 1997, Sullivan, Zevenbergen, & Mousley, 2003). Crawford and White (1999) explain four common attributes called “contextual teaching strategies,” that focus on teaching and learning in a context (p. 35). These four contextual teaching strategies consist of relating, experiencing, applying, and cooperating. The three reasons to use contextual teaching styles in the classroom play a role in these four strategies. This chapter is therefore organized around Crawford’s and White’s four contextual teaching strategies with connections made to each of the three motives.

### *Relating*

Gravemeijer and Doorman (1999) explain that the role of context problems are most commonly addressed at the end of a learning sequence-“as a kind of add on” (p.111); however, they may be play a more central role in mathematics today. This is due to the fact that today’s emphasis is now more focused on the usefulness of what is learned, and because of the motivational power context problems possess (see introduction chapter). The first contextual teaching strategy discussed by Crawford and White is relating. Relating is recognized by Crawford and White (1999) as the most powerful contextual teaching strategy because it is used to mean “learning in the context of one’s life experiences” (p. 35.) When teachers use the strategy of relating, they are taking a new concept and relating it to something already familiar to the students. For example, Crawford and White (1999) explain a situation where students are presented with the new concept of ratios. A teacher presents the students with the idea of making fruit punch with 3 cans of water and 2 cans concentrate. When the students are presented with the fruit punch example first, most students feel that they already know about ratios because they have experienced making fruit punch before.

They are able to relate their experience of making fruit punch with a new mathematical concept of ratios. Since they have already experienced the idea of using ratios, White and Crawford (1999) entail that they are more likely to remember the definition of ratio because they will be able to relate it to their fruit punch making experience.

One theory that supports the contextual teaching strategy of relating is the theory of Realistic Mathematics Education (RME). Uzel and Uyangor, (2006) state “RME theory is a promising direction to improve and enhance learners’ understandings in mathematics” (p. 1952). The major theory behind RME is that students will learn mathematics through the activity of doing the mathematics. This activity consists of experiencing mathematics through solving real life situations, often called contextual problems. Within these contextual situations, students are able to relate everyday life situations to the mathematics being taught. Uzel and Uyangor (2006) explain that researcher Hans Freudenthal’s view on RME consist of mathematics as a human activity and emphasizes the actual activity of doing mathematics. One of Freudenthal’s important points of view is that mathematics must be connected to reality. The mathematics must be close to the students and be relevant to everyday life situations. The context in the problems that are presented to the students can be a real world situation where students are able to relate to the situation. For example, Gregg and Yackel (2002) designed an instructional sequence focused on an activity which was developed to promote the concepts of place-value numeration for second and third grade students. In this sequence, students are presented with a scenario about a family that owns a candy shop and are trying to figure out how many pieces of candy they should put in rolls, in boxes, and in cases. The students are presented with different scenarios about the candies

and are asked to find unknown quantities about the candies and how they are packaged. Students start off by making different pictures of the how the candy can be packaged and then they solve word problems where they are asked to figure out how many of a specific type of candy is in the candy shop. This activity helps students to learn how to represent quantities and solve for the quantities. Gregg and Yackel (2002) address the main purpose of this activity which is to “ground students’ mathematical activity in real world imagery.” When students are learning math through activities such as this candy shop sequence, they are able to relate their experiences with candy and buying candy at a candy shop to learning the math behind it. RME allows students to be presented with an everyday situation that they can relate to and learn the math through their own life experience with the situation that is involved.

The strategy of relating allows for the mathematics to become more meaningful to the students. As stated previously, Crawford and White (1999) explain that students will most likely remember the definition of ratio because of the relation it has to the fruit punch instructions. When students are able to remember such mathematical concepts in this approach, the math has become more meaningful to them. Verhage and Lange (1996) explain that “meaningful mathematics has to be learned in a meaningful way” (p. 14). If students are relating the mathematics to their own life experiences, then the mathematics has meaning to them.

When teachers implement activities that allow for relating to occur, the realistic math that is involved provides meaningful mathematics as well. The Candy Shop activity (2002) also allows for the mathematics to become more meaningful to the students. As previously

stated, this activity allows students to relate to the idea of buying and selling candy. Gregg and Yackel (2002) state

“the students’ use of symbols to record and communicate their actions in a realistic scenario can support their development of meaning for algebraic expressions and operations. Furthermore, it demonstrates the importance of the notion of an algebraic expression as a quantity and translates that expression into a meaning mathematical object for students “(p. 497).

This means that the mathematical knowledge that students develop while doing relating activities becomes more meaningful for the students because of the realistic nature the scenarios represent. The realistic scenarios that are embedded in activities such as the Candy Shop activity provide students with mathematical concepts that develop more meaning to them because of the relationship that they have with the scenarios.

### *Applying*

Students are also able to learn in a contextual setting when they have already been taught the math concepts. When students are taking their previously learned knowledge of a specific mathematical concept and applying it to learning with a context situation, they are using the strategy of applying. The strategy applying is defined by White and Crawford (1999) as “learning by putting the concepts to use” (p. 36.) For example Pedrotti and Chamberlain (1995) discuss the use of the program CORD Applied Mathematics. CORD is a program that allows students to be presented with real world problem solving activities and hands-on laboratory activities that show the applications of the concepts. With this program, students are able to come to grips with the mathematics contained in the unit. By applying

their math knowledge to activities such as these, students are able to make meaningful connections between mathematics and application.

The contextual teaching strategy of applying is also shown through Irwin's work. Irwin (2001) conducted a research study to see if students' understanding of decimals could be improved by applying their understanding of the math concept to problem solving activities set in everyday context. The investigation involved two groups of students where one group solved decimal-fraction problems set in a variety of contexts while the other group solved similar problems, but without contexts. The contexts that were selected in this study included different sizes of soft drink bottles, monetary exchange between countries, and other uses of metric measurement. The students that were able to solve the problems with a context were able to apply their knowledge of decimal-fractions to these problems and find a solution. For example, one of the contextualized problems read as follows:

“If you go on a trip and you buy 1 liter of petrol at 90.9 cents and a meal at McDonalds' at \$4.95, how much will it cost?”

Students who were not in the group that solved contextualized problems saw this problem:

“If you add  $90 \frac{9}{10}$  and 4.95 what will your answer be?”

The study showed a larger improvement from the pretest scores to the posttest scores from the group of students who applied their knowledge of decimals to contextualized problems rather than noncontextualized problems. Both groups did show improvement, but the students who were working with contextualized problems had a larger percent increase in improvement. Irwin (2001) explains that when students actually put the math concepts they have learned to use, then they are interested in the material and show improvement in their

work. One pair of students that was involved in the contextualized problems was able to use a clipping from the newspaper that allowed them to use this information to give meaning to their decisions while working on the problem (Irwin, 2001). The students seemed very intrigued in the problem and were able to apply both their knowledge of decimals and their use of everyday knowledge to the problem to find a correct solution.

For applying mathematics, teachers can use realistic exercises in order to motivate a need for mathematics. Crawford and White (1999) explain that when teachers are applying the math to the students, exercises and activities that promote realistic math are important for a math application to be motivational for the students. The contextual teaching strategy of applying has the ability to promote realistic math to students with exercises that demonstrate the usefulness of mathematics in a student's life.

### *Experiencing*

When teachers are teaching students new concepts through discovery, this allows for students to experience the investigation of the new concept by learning by doing. Crawford and White (1999) explain that experiencing is a contextual teaching strategy that lets students learn new knowledge through exploration, discovery and invention. There are at least three general categories of hands-on experiences that create meaning for students. They are manipulatives, such as using algebra tiles to learn how to factor using completing the square, laboratory activities where students can collect and analyze data on their own measurements, and problem-solving activities. Heuvel-Panhuizen (2002) explains how a problem-solving activity for first graders helped them to discover formal mathematical language. The activity starts off with a "real life" situation where the students act as the driver on a bus. As the

passengers are getting on and off the bus, the students were to determine the number of passengers in the bus at each stop. With the use of a contextual situation, students were able to experience formal mathematical language as well as discovering numerical operations and expressing operations with pure numbers.

White and Crawford (1999) describe another example of a problem-solving activity that goes back to the fruit punch example mentioned earlier. One teacher asked her students “How many cans of concentrate and how many cans of water are needed to make punch for the whole class?” (p. 35). This question makes this a problem-solving activity because there are several different ways students can approach this problem which can lead to several different solutions and the students may not know immediately how to do the problem. Once students have found their own solution, the students as a class can come together and decide on a single best solution and then actually make the fruit punch to check their answers. This activity shows how students are experiencing ratios by figuring out how to make fruit punch for their whole class.

The strategy of experiencing allows for students to interact in problem solving activities that motivate student learning. When students are placed in a problem solving environment they are motivated by the learning. According to Crawford and White (1999), problem solving activities can be hands-on activities that “engage students’ creativity while teaching problem solving skills, mathematical thinking, communication, and group interaction. These characteristics create a problem solving environment. Connect to this, Hmelo-Silver (2004) discusses a type of learning that consists of a problem solving environment that promotes motivation for students. According to Hmelo-Silver (2004),

“Problem-based learning is an instructional method in which students learn through facilitated problem solving” (p. 235). Problem-based learning provides students with meaningful and experiential learning where students learn by solving problems that reflect on their experiences (Hmelo-Silver 2004). Since the problems in this type of environment reflect real-world problems, students become more active learners. Hmelo-Silver also suggests that educators are interested in this type of learning environment because of its “potential for motivating students” (p. 236).

### *Cooperating*

Problem-solving activities can sometimes be difficult for students because of the complexity that they possess. When students work individually, they might not make significant progress and can become frustrated with the problem; however, when students work in groups, several ideas all come together and students are able to learn from one another. Cooperating is the fourth contextual teaching strategy defined by Crawford and White (1999) as “learning in the context of sharing, responding, and communicating with other learners” (p. 37). Pedrotti and Chamberlain (1995) explain that CORD mathematics designs activities that encourage problem solving in small cooperative-learning groups. When students work in cooperative-learning groups, they can share opinions and solve problems together so that they are able to make meaningful connections between the math and the context they are working with. When groups are finished with their activity, groups should be able to compare and share their findings with other groups so that everyone is interacting together. CORD mathematics suggests that “teams are encouraged to summarize their findings and present their results to their classmates” (p. 706). Also, in Irwin’s (2001)

study, she asked the students to work in partners because she wanted to see a sign of productive peer collaboration in which partners were discussing and arguing as peers which would enable them to learn from each other. Her study also shows that using groups in a contextual setting benefits students as well because they are able to draw ideas from their everyday knowledge. In her study, one pair of partners who worked with contextualized problems was able to use their ideas of currency exchange to discuss how they should approach the problem. In a contextual setting, students who are working together are able to use and share their everyday knowledge of different concepts and apply that knowledge to finding a solution to the problem.

In cooperative learning, students are able to collaborate together and discuss different ideas with one another. This contextual teaching style promotes motivation throughout the classroom. Abrami and Chambers (1996) state “when students actively collaborate, they are motivated to help one another and themselves to achieve” (p. 71). Cooperating helps students to become more motivated in the learning because they are able to get help from their peers and also give help to them as well. This type of learning in a contextual setting allows for students share their experiences that relate to the math which also motivates the students to learn. Abrami and Chambers (1996) suggest that cooperative learning serves to motivate students to learn, help group members to learn and encourages group members to learn.

I propose that the study that I conducted is strongly connected to the two strategies of relating and applying. When students received the contextual lesson plan first, they were using the strategy of relating, as they learned the mathematics by relating it first to a real

situation. Conversely, the class that received the traditional lesson first, then the contextual lesson, was using the strategy of applying, as they first learned the mathematics, and then applied it to the context. The other two strategies, experiencing and cooperating, support the reason why using contextual settings in the classroom is beneficial to students.

#### *Contextual Setting's role in Different Levels of Ranked Students*

The second research question in this study involves determining if learning in a contextual setting helps the performance level of higher, middle, and lower ranked students. This idea compliments Irwin's research of investigating students' knowledge of decimals in a contextualized setting. While only focusing on higher and lower ranked students, Irwin (2001) found that lower ranked students who worked on contextualized problems with a partner improved from pretest of 19% to posttest of 32%; contextualized, higher ranked students improved from 34% to 48%; noncontextualized lower ranked students improved from 21% to 27%; and the noncontextualized, higher ranked students improved from 45% to 52%.

In other research, Mankin, Boone, Flores, and Willyard (2001) conducted a study to find what specific attributes in ones' teaching style motivate students' learning. Using student perspectives, the study was conducted to identify detailed characteristics and activities that motivate students to learn in the College of Agriculture at Kansas State University. One of the objectives was what type of teaching style motivates students and the second objective was to determine if the results differed by student grade point average. The study concluded that both lower ranked and lower GPA students, less than a 3.0, and higher ranked and higher GPA students, greater than a 3.0, are motivated by teaching styles that

make the subject interesting by incorporating the use of real life examples. If students are motivated by the use of contextualized problems, then this could improve their performance in the classroom.

More research that supports the idea that lower ranked students can learn better in a contextual setting is from Barnes. Barnes (2005) explains how when low attaining students are introduced to a task that makes sense, then there is a good chance they might surprise us with what they can achieve in mathematics. In this article low attaining students refers to students who do not meet the required standard of mathematics performance as set out by the school. Barnes (2006) suggests that low attaining learners may learn incidentally when they are doing an activity that promotes engagement and active participation. These activities help lower attaining students learn because they find inconsistencies in their thinking, which they then try to figure out. Learning in a social or cultural context allows for lower attaining students to become a more effective learner in mathematics.

#### *Summary*

In this section, I focused on Crawford's and White's contextual teaching strategies for teaching and learning mathematics in a contextual setting. Each of their discussed strategies is used in order to help both teachers and students understand how math is related outside the classroom. They help teachers figure out what type of lesson plans they can create so that they can engage the students in the learning of mathematics through life experiences and they help students see how their life experiences relate to math. The four contextual teaching strategies, with their connections to the three motives to use contextual settings in the classroom, help to support and encourage learning math in a contextual setting.

Other literature provides evidence that learning with a context improves lower and higher academically ranked students' performance. Researchers offered a few reasons for this phenomenon. Barnes (2005) offered the idea that low attaining students may learn "incidentally" as they participate in the activities in context. Other researchers mentioned that both higher and lower ranked students are more motivated by learning when they are exposed to real life examples (Mankin, Boone, Flores, & Willyard, 2001). Overall, learning in a contextual setting provides motivation on both higher and lower ranked students which might have the ability to increase all students' academic performance.

## CHAPTER 3

### METHODOLOGY

#### *Purpose*

This study was conducted to learn more about the teaching of high school mathematics; it involved working in two Algebra I classes at a large public high school. The purpose of the research was to investigate the implementation of two different instructional methods. The study determined if the order of instruction, learning in context before or after traditional instruction, affects students' level of academic performance and their attitudes toward learning. The study used a quasi-experimental design (Campbell & Stanley, 1963). For the experimental group, the treatment consisted of students receiving the instruction of learning in a contextual setting first, then learning the same material in the traditional approach. The mathematics that was being taught during this study was learning how to solve one and two step equations. The control group did not receive the treatment; therefore, it received the traditional lesson on Day 1 and the contextual lesson plan on Day 2, as it would usually occur in a high school mathematics classroom. The study also examined how the order of instruction, with respect to a context, affects different academically performing students' mathematical learning. The following chapter describes the students and teachers participating in this study, the setting, the data collection plan and how the data is analyzed.

#### *School, Students and Teacher*

Research was conducted in a large high school located in a city near Raleigh, North Carolina with an enrollment of 2, 215 students. According to the schools mission statement, this school follows a traditional curriculum where students have the opportunity to have high

quality instruction including creative exploration and extra-curricular activities

(<http://www.wcpss.net/school-directory/316.html>).

The subjects of this study consisted of 49 high school freshman who are taking Algebra I with technology. Algebra 1 with technology is more advanced than Algebra 1 because it requires the students to use the graphing calculator for several of the mathematical concepts taught. There were two classes involved, as mentioned above. The first period class had a total of 22 students where there were 9 males and 13 females. The second period class had a total of 27 students where there were 13 males and 14 females. From a survey the students answered (Appendix E), I obtained the following data shown in Table 1 and Table 2.

Table 1

*Percentages of Math Classes that Students were Previously Enrolled*

	8 Grade Math Plus	Algebra 1 Part 1	Pre-Algebra	Advanced Pre-Algebra	Jr. High Math
1 <sup>st</sup> Period (experimental class)	60%	0%	18%	5%	10%
2 <sup>nd</sup> Period (control class)	81%	15%	4%	0%	0%

From this table, one can see that no students in the experimental class had ever taken Algebra before. The Experimental class had a lower percent of students (60%) who finished 8<sup>th</sup> Grade Math plus. They also had higher percentage of pre-algebra students. Probably the most important information this provides is that there are no repeat takers of Algebra 1 with Technology in both classes, and only a small number of Algebra repeaters in the control class.

In order to determine if the level of academic performance in both classes was equal before beginning the experiment, I chose to look at two measures, the results of the pretest and the teacher's academic ranked of the students. The pretest (Appendix C) was out of a score of 12 points. The averages are shown in Table 2.

Table 2

*Average Scores on Pretest for Control and Experimental Groups.*

Control Group's Average Score on Pretest	Experimental Group's Average Score on Pretest
8.79	7.52

By looking at the averages only, the control group seems to have done better on the pretest than the experimental group. Therefore, a t-Test was performed; a t-Test is a hypothesis test about the difference between two populations. The assumptions for hypothesis tests are: normal populations and samples were random and independently selected; we assume that the two samples are independent random samples, and both populations are normally distributed. The t-Test results are shown in Table 3.

Table 3

*Results of t-Test for Averages on Pretests for Control and Experimental Groups*

Hypothesis:		
$H_0: \mu_1 = \mu_2$ versus $H_a: \mu_1 \neq \mu_2$		
t-Test: Two-Sample Assuming Unequal Variances at alpha level .05		
t-Test: Two-Sample Assuming Unequal Variances at alpha level 0.05		
	<i>Experimental</i>	<i>Control</i>
Mean	7.52381	8.788461538
Variance	10.2619	9.183461538
Observations	21	26
Hypothesized Mean Difference	0	
Df	42	
t Stat	-1.37831	
P(T<=t) two-tail	0.175405	
t Critical two-tail	2.018082	

At an alpha level of .05, there is insufficient evidence to say that there is a significant difference in the academic level of performance for the two classes. I also conducted a t-Test at an alpha level of 0.10, and still found out that there is insufficient evidence to claim a difference in the students' academic performance in the two classes.

Another validation I used in showing that the two classes were approximately the same academically was by asking the teacher to give me her opinion of the students' ranks in the classes. The teacher ranked the students with a letter grade that correlated to the average the students had during that time during the semester. The experimental group consisted of the following approximate averages: 9 A's, 9 B's, 2 D's. The control group had the

following: 12 A's, 11 B's, 2 D's, 1 F. These averages show that there is clearly no evidence that one class performs higher than the other.

The teacher involved in this study, also teaches Advanced Functions and Modeling and taught Algebra II last year. She is a second year teacher and this is also her second year teaching at this specific high school. She graduated from a four year university in Raleigh, NC and obtained a Bachelors of Science degree in Mathematics Education. Along with her degree, she also received her North Carolina Teacher's License for grades 9-12. With her background in computer science, she teaches afterschool at an institute that teaches children both math and computer science skills.

#### *Setting*

Both Algebra I classes are held in the same classroom. The classroom is set up so that half of the students sit on one side of the classroom and the other half sits on the other side. This allows the teacher to have a large middle area where she can observe her students. The desks area also arranged so that it is easy for the students to work in pairs. At the front of the class, there is a small white board, but the teacher uses an overhead projector when doing her lessons. The teacher's desk along with one computer is in the back of the classroom. The classroom is shown in Figure 1.

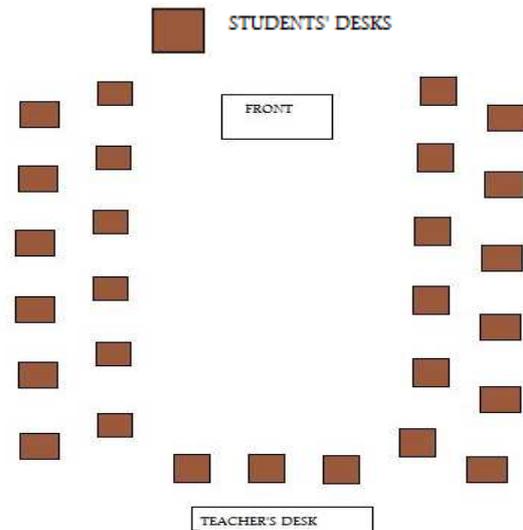


Figure 1. Model of the classroom

The textbook and student workbook used in the class is *Prentice Hall Mathematics Algebra 1*. The students used both resources for in-class work and homework. When both classes received the traditional lesson plan, the teacher used her own lesson plan that she created with the help of the textbook (Appendix B.) The lesson plan the teacher used was created by the Professional Learning Community (PLC) in the math department at her school last year. Once she received this lesson, she modified the lesson. The original lesson plan was designed for a two day lesson plan; however, in order to meet my accommodations for the study, she revised the lesson so that it would only take one day. The contextual lesson plan (Appendix A) consisted of an activity that I created. The first part of the contextual lesson consisted of a page that contained a written scenario (Appendix A) where the partners had to use their imagination on what they enjoy doing on a Friday night out with their friends. They

had to discuss with their partner all the options there are to do before and after going to a concert and also discuss how much money they would need for certain chosen activities. This scenario was used as an opening activity to get the students motivated for the lesson before they started to learn the specific math topics involved. The rest of the lesson built on this scenario and followed up with embedded instruction and exercises about one and two step equations. The rest of the instructional activity consisted of a packet that was a scripted lesson plan where the students worked in pairs, read and followed along, worked problems as they read and discussed the material. The packet consisted of several different examples on how to solve one and two step equations, followed by practice contextual problems for them to work. In addition, once the students finished going through the examples, there were 10 context problems about the Friday night out at the end of the packet that they had to complete with their partner

The design of the contextual lesson plan was focused around the three motives for teaching and learning in a contextual setting mentioned in the introduction: motivates students, makes the math realistic, and allows the math to become more meaningful. The lesson plan was focused on spending a Friday night out on the town with \$200 to spend. I felt that this scenario would motivate the students to learn the math behind the lesson because it is something that they are interested in. Most students enjoy going out on a Friday night with their friends and like to spend money on exciting events such as concerts. By creating a scenario that the students are attracted to, allows the students to become motivated to learn the math because they are personally interested in the scenario. The nature of the lesson plan allows for the math to take on a realistic setting as well. Students can relate to the idea of

going out on a Friday night with their friends and spending money. Since the scenario is a situation in which students see the relevance, then the math becomes realistic to them as well. They are able to understand that the math involved in this lesson plan can play a role outside the classroom. The lesson plan also allows for the math to become more meaningful to the students as it helps the students to make a clear connection to the math and the real life situation. The following example from the contextual lesson plan, illustrates how these previously mentioned motives work here.

Example: After dinner, you have \$182 to spend. If you want to leave the concert with \$145, which concert ticket should you purchase?

This problem is able to motivate students they can relate to the situation. They have been given an amount of money to spend on a concert ticket, but wish to leave the concert with \$145. This type of problem motivates students to figure out which concert they can see in order to still have money left over at the end of the concert. The students are able to see how the math is realistic because it has to do with buying concert tickets which is an experience that most students have already experienced or might experience in the future. The math is meaningful because they are able to see and understand the connection of the amount of money they have to spend to which concert ticket they can purchase in order to have a certain amount left at the end of the night. All three motives are used throughout this lesson plan in order for students to learn successfully in a contextualized setting.

#### Data Collection

As stated before there were two Algebra 1 classes participating in the research which was conducted over three classroom periods. The first period class was the experimental

group. On Day 1, the experimental group learned in a contextual setting by working through the materials I had created for them to do (Appendix A.) The control group was the teacher's second period class. On day one of the study, the control group learned the math through a traditional teaching approach. The classroom teacher created a lesson for the class which consisted of the teacher lecturing to the class about the material while the students sat down and took notes (See earlier for description). Before instruction started in both classes, the students took a pretest.

On the second day, the instruction was reversed. In order to find out how the order of the two types of instruction affect students learning and their attitudes towards the math, the experimental group received the traditional based approach while the control group received the contextual lesson plan. The lesson plans were the same for both classes, just the order they were given was the main difference. The material was also the same from Day 1 to Day 2. Both classes were learning how to solve one and two step equations. On the third day, the students took a posttest and filled out a survey.

The study involved collecting and analyzing both quantitative and qualitative data; there were four kinds of data collected, including a pretest and posttest, a survey, and observations. I chose to collect this data because I felt that this set of data would facilitate answering my research questions. The pretest and posttest provided me with quantitative data that aided me in determining if there was a significant difference in the initial instruction of learning in a contextual setting compared to initial instruction of learning in a traditional teaching style approach. This data also determined if there was a significant difference in higher ranked students and lower ranked students between the two different groups of

students. The survey and observations gave me qualitative data that allowed me to determine how the different type of initial instruction affect students' attitudes toward learning along with students reactions to the initial instruction while the lesson was taking place.

The pretest (Appendix C) was a five question short answer quiz about the material the students were going to learn in the next two day's instruction. The purpose of this pretest was to determine what they already knew about one and two step equations. The pretest scores also helped me to determine that there was no significant difference in the levels of academic performance between the experimental group and the control group as discussed in an earlier section. The posttest (Appendix D) was a five question short answer quiz about one and two step equations that was administered on the third day of the study. Both the pretest and posttest were scored on a 12 point scale. For both tests, the first three problems were worth 2 points each and consisted of equations where the students had to solve for the variable. The last two problems were word problems and they both were worth 3 points each. The pretest and posttest scores allowed me to determine the change in the performance of the students from the beginning of the study to the end.

For the study, I decided to observe while the lessons were implemented. When observing, I concentrated on how the students reacted to the lessons. As the class did the contextual lesson plan, they were able to work in groups so I decided to focus on three small groups for each class on how they worked together and their attitudes about learning with the activity. I took field notes about the activity I observed when students were speaking and the conversation that occurred. When observing the traditional based lessons in both classes, I watched a variety of students to see how they interacted with the lecture based lesson. I took

field notes about how they responded to the lessons, which students answered questions, which ones were not focused on the teacher, and other behaviors that might indicate attitude towards the lesson. In the results chapter, I report the data from these observations for each classroom.

The survey (Appendix E) used in this study had the purpose of collecting data to determine how the learning affected the students' attitudes toward the learning of the math. I was also able to find out what type of math background they had. Both classes took the survey on the third day. The survey also asked the students questions about the type of instruction they received on the first day of instruction and what they liked, what they did not like, and how they might improve the lesson in terms of their own learning. In order to keep all the data anonymous, the teacher assigned the students a class number at random that the students put on all the data that was collected. Only the teacher knew which number correlated with each student.

#### *Quantitative Data Analysis*

In order to determine if the order of instruction of using a contextual lesson versus a traditional based lesson is significantly different, I first used the students' scores on the pretest and posttest (see Appendices C and D). Although the scores on a test do not prove the students are learning, it is a proxy for learning that is acceptable in this situation. I found each of the class averages of the scores on the students' pretests, posttests, and compared the change in these scores.

Next, in order to determine if there is a significant difference in the order of learning with a context first, then traditional based learning, compared to traditional based learning

then learning in a contextual setting, I compared the two groups' mean improvement, or gain scores, which is the average of the individual differences in pretest and posttest scores in each class. A t-Test is most commonly used to evaluate the differences in means between two groups (Johnson, 1996). The reason I used the t-Test is due to the small sample sizes I used for the study. The  $p$ -level of the t-test represents the probability of error involved in accepting the research hypothesis about the existence of a difference in the two types of initial instruction. The outcome of the  $p$ -level will tell me to reject or fail to reject the null hypothesis of the t-test which will give me evidence to conclude if there is or is not a difference in the two types of initial instruction.

Additionally, I used other data analysis techniques to study the scores in more depth. I looked at the individual improvements graphically and I analyzed spreads using dot plots and whisker plots.

Turning to the second question, when determining the ranks of the students in both the experimental and control group, I ranked them according to their pretest scores they received. Figure 2 shows the distribution of pretest scores from the control and experimental groups. While analyzing the distribution, I felt that it was necessary to break down the ranks into three levels: higher ranked, middle ranked, and lower ranked. The higher ranked students are those who received a score greater than a 9. The reason for this grouping is due to the fact that the last 6 points of the pretest came from the two contextualized problems, which were the two hardest problems. If a student received a score greater than a 9, then they were either able to get both of the hard problems correct, or at least managed to get partial credit from them. Since they were able to solve or attempt to solve the harder problems, then

these students were considered to be higher ranked students. A student who received a score greater than a 5, but less than a 10, was considered to be a middle ranked student. This meant that the student was able to get a maximum score of a 9, meaning that he or she was unable to solve both of the harder problems and may have just received partial credit on the two problems. If a student received a score of a 5 or less, then that student was considered to be a lower ranked student. This meant that the student was unable to solve or obtain partial credit from the two hardest problems and was only able to solve or receive partial credit from the easier three problems that were only worth 2 points each. Table 4 shows the number of students who were a higher ranked, middle ranked, and lower ranked in both the experimental and control group.

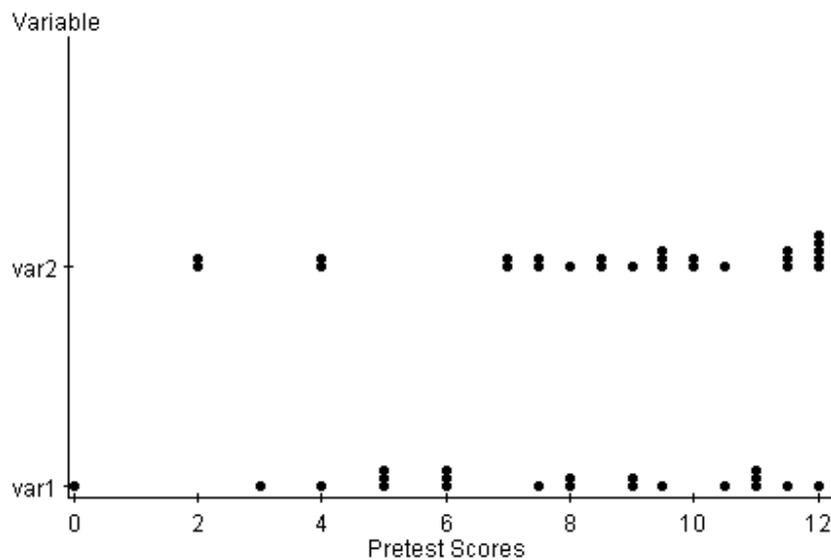


Figure 2. Distribution of pretest scores

Table 4

*Student Rankings for Experimental Group and Control Group*

	Number of Higher Ranked Students	Number of Middle Ranked Students	Number of Lower Ranked Students
Experimental	7	8	6
Control	14	8	4

The ranking system that I created contrasts with Irwin's (2001) study. In her study, she focused on two groups: higher ranked and lower ranked students. I decided to break down the rankings into three groups because I saw a clear distinction within the distributions and saw it appropriate to rank the students accordingly.

When determining what type of quantitative analysis I should perform when evaluating the students in the three groups, I decided not to perform t-Tests because of low numbers of students. I instead found the improvement in scores by calculating the averages of the pretest and posttest and compared the increase from the pretest to the posttest in all three of the ranked groups.

*Qualitative Data Analysis*

The observations that I collected were used to answer my research question on how students' attitudes are affected by the order of instruction of the two types of instruction. For this piece of data, there was little data analysis involved. The observations were used primarily to serve as a description of how the students reacted to the lessons.

The responses to the survey allowed me to investigate what students thought about the lessons. For the survey, I created a table (see Table 6) with the questions and the types of

answers I received from the students from both groups and made a count of how many students replied with that type of answer. This allowed me to see the different types of responses about the contextual lesson and find some similar reactions as well. The responses also allowed me to develop an idea of how the lesson affected students' attitudes toward learning math; I was able to find different types of positive and negative reactions. After completing the table, I decided to make a smaller table (see Table 7) that listed the different themes to represent a majority of the types of responses I got from both groups from the surveys (Miles & Huberman, 1994). The themes that I found helped me to discover the key attitudes for the students. Overall, the responses from the survey helped me to gain insight on how the students felt about the two types of instruction and helped me to evaluate their attitudes toward the teaching.

## CHAPTER 4

### RESULTS

In this chapter, I report on the results of the study. The first section is a detailed description of the data that was collected during the observations I made on both days during the first and second period class. The first period class was the experimental group, which was the group that received the treatment of working on the contextual lesson on Day 1, then the traditional based lesson on Day 2. The second period class was the control group, which did not receive the treatment, and received the traditional based lesson on Day 1, then worked on the contextual lesson on Day 2. During the observations, I focused my attention on a few students to see how they reacted to the instruction. In the first section of this chapter, I will describe the observations in the first section. The second section reports the analysis of the survey administered on the third day. The third section describes the results of the exploratory data and statistical analyses I did on the pretest and posttest data. The first analysis looks at the individual improvement differences from the pretest to the posttest in both groups. The second analysis compares the mean improvements from the pretest to the posttest in the experimental group with the control group. The third analysis shows the results of t-Test that was used to find out if there was a significant difference in the order of the two types of instructions. The fourth analysis looks more closely at the individual improvements from the pretest to posttest in both groups with the use of graphical representations. The last data analysis evaluates the mean improvements from the pretest to the posttest in higher, middle, and lower ranked students in the experimental group versus the control group.

## Qualitative Results

### *Observations: Day 1*

Experimental Group. On Day one of the study, the first period class, which was the experimental group, first took the pretest to test their knowledge of one and two step equations. The teacher allowed the students approximately 7 minutes to complete the pretest. After completion of the pretest, students were then assigned a partner. Once the students moved to sit with their assigned partner, the teacher read aloud the first part of the instructional packet. I decided to focus my observation and take notes on three main groups:

- Group 1 : one girl, one boy
- Group 2: two girls
- Group 3: two boys.

During the opening task, all three groups appeared involved and excited because they were able to come up with their own ideas on what they wanted to do. I noticed that Group 1 was quieter than the other groups and did not want to discuss different options. I took into account that this is only the second week of school and the students are still getting to know one another. I was intrigued with Group 3 during this task because they were able to be very creative with their ideas on what they were going to spend their money on and how much these certain items would cost. I could tell they were using their everyday knowledge of going to a concert to enter into this activity. I heard them mention things such as VIP passes, t-shirts and how much parking would be at this concert. This particular group was motivated by this opening activity and kept that excitement when it was time to work on the packet of problems.

After students had time to do the opening task, the teacher asked some of the students to share their ideas. Some students described their options as buying t-shirts, going out to dinner before the concert, buying a CD at the concert, paying for parking at the concert and going to the movies. The students really got into the opening activity and were very specific in the activities they chose to do and explained how much each option would cost. After sharing their ideas, the teacher then handed out the second part of the instructional task, which was the packet described above, and she read aloud the scenario. Once she was finished reading, the students began to work on their packets in their assigned group. While watching Group 1, I noticed that they were reading the examples in the beginning of the packet at first, but then just skipped right to the section of the set of 10 problems. However, I did notice that they did go back and refer to the examples that were in the beginning of the packet because they did seem confused on how to solve the problems. Group 1 also worked very quietly and did most of their work independently. Group 2, which was the group with the two girls, were reading the examples aloud to one another and did follow the examples before going straight to the set of 10 problems. When the girls did go to the set of 10 problems they started to ask Group 3 for some help so all four students were working together and reading the problems to each other and making sure everyone was setting up the correct equations. This observation supports Crawford's and White's (2003) contextual teaching strategy of cooperating. The group of girls seemed confused and unsure if they were setting up the equations correctly, so they felt comfortable enough to ask another group for help. When working in groups, Crawford and White (2003) explain that it is

common for students to feel less self-consciousness and feel confident about asking questions without a risk of embarrassment.

The class finished up this part of the instructional sequence in 45 minutes and for the most part, was very quiet and there were a couple of groups that worked individually. At the end of class, the teacher asked the students to get together with other groups and check their answers with each other. The teacher also did problem number 7 at the end of the class so they could see if the students did the problem correctly. The class seemed to understand the problem and agreed with the teacher on how to solve it.

Control Group. The second period class, the control group, had a different reaction to their lesson. The initial instruction in the control class was learning the mathematics of solving one and two step equations in the traditional teaching approach. The teacher had a lecture planned out for the students that consisted of several notes and examples. After the students took the pretest, the teacher placed the notes up on the overhead and gave the students five minutes to copy down all the notes before she went over them. I asked the teacher why she does that and she explained to me that she feels the students learn better because they can listen better and follow the teacher better because they aren't busy trying to write down all the notes.

After the students wrote down the notes, the teacher started going over the notes which began with learning about the addition and subtraction property of equality. During this time, I again decided to concentrate on three different people. The first person I observed was a female. While the teacher is going over how to solve one step equations, the girl is not paying any attention to the lecture and is writing in her planner during this time.

She did not even write out the steps involved that the teacher was writing out in solving the specific equation. I also noticed a male student not paying attention and was putting his head down on his desk. The teacher did try to get the class involved several different times by asking questions to specific students and to the whole class. When questions were asked to the whole class, there was not any participation, which led the teacher to start asking specific students. When students were called on, they did appear to understand what was going on and could answer the questions correctly. Another boy I was observing was also not taking any notes. He decided to go ahead and start working on his homework and was doing his homework out of the workbook.

When the teacher got to the word problem examples, the students seemed to become more interested in working out the problems by themselves and then giving input when the teacher asked how they worked it out. The word problem that was used during this time was: “Together you and your puppy weigh 128lbs. If you alone weigh 115 lbs, how much does your puppy weigh?” The boy that was working on his homework earlier in the class volunteered his way to solve the problem and said the following: “If you subtract 115 from 128, you get 13 lbs which is how much your puppy weighs” The teacher then asked for him to give her the equation he used. He said “ $128 - 115 = x$ .” The teacher did explain that this is correct, but also showed the students another way to work out the problem by saying “ $115 + x = 128$ .” She explained to the class that both equations were correct and that there can sometimes be different ways to set up equations. After the puppy example, the teacher continued to teach the students about two step equations and the students continued to respond in the same way.

*Observations: Day 2*

Experimental Group. On Day 2 of the study, the instructions were reversed as noted in the methodology. The first period class started off the class by going over homework problems they were assigned from the previous day. After about 5 minutes going over homework problems, the teacher placed the notes on the overhead so students could first write them down before she went over the material. The notes started off as the same as they did in the control group's lesson on Day 1, which was learning about properties and giving examples of one step equations. As the teacher continued with her lesson, I concentrated on three different students; all were individuals I concentrated on, on Day 1. On Day 1, I concentrated on the following groups:

- Group 1 : one girl, one boy
- Group 2: two girls
- Group 3: two boys.

For Day 2, I focused on the boy from Group 1 (boy A), one of the girls from Group 2, and one of the boys from Group 3 (boy B). While the teacher was asking questions to the whole class, the class did not give any responses. Most students were busy doing other things besides taking notes such as talking, doing homework, and laying their heads on their desks. This type of response continued throughout the lesson. I did not get much from the three students I observed during this time besides the fact that they did not seem to have the same motivation that they had in the previous day's instruction. They sat in their seats quietly, and took notes and gave very little input during the class discussion. Their motivation level

dropped significantly during this lesson. They did not seem excited about the learning and were not interested in giving any type of effort into the lesson.

Control Group. On Day 2 for the control group, however, there was a different atmosphere than the experimental group's lesson on Day 2. I tried to watch the same students, and their partners, I focused on from Day 1. On Day 1, I focused on two females and one male. These groups were as follows:

Group 1: two girls

Group 2: one boy, one girl

Group 3: one boy, one girl

The lesson started off with the partners doing the opening activity of the contextual lesson. The students seemed to really be excited by the lesson and thought of several different things they could spend the money on. One student commented that she did not believe that the situation was actual realistic because her parents would never give her 200 dollars. This was the only comment I heard that gave me reason to believe the students did not see themselves relating to the activity.

Group 1 was interested in determining which bands they would go see and the things they could buy at the concert such as glow sticks and t-shirts. One really interesting remark was made by Group 3 when discussing the issue on rather or not to rent chairs when they got to the concert so that they would not have to sit on the ground. They decided that it would be cheaper for them to purchase the chairs at Wal-Mart than renting them at the concert. This is evidence that the students can relate to this experience because they know how expensive concert supplies can be and wanted to go the cheapest route so that they could have more

money at the end of the night to keep. Group 2 was interested in going to a cheap restaurant such as McDonalds before the concert so that they would have more money to spend at the concert.

After students had time to do this opening activity, they shared some of their ideas with the group then worked on the instructional packet that the experimental class did on Day 1. This class seemed more interesting in working in groups than the experimental class. They were defiantly utilizing this advantage by working with their partner and getting help from one another. One observation I noticed that was very interesting came from Group 3. Group 3 decided to take the information they came up with from the opening activity and use the prices from the menu options from the packet, and developed their own equation. Their equation added up the expenses they used for their night adventure, and they were able to find out how much money they had left over at the end of the night to keep. This observation proves that the students were interested and motivated by the lesson and were able to relate the lesson to a typical Friday night out on the town. Group 2 did a good job of following along with the packet. The students were reading the examples to each other and solving the examples before getting to the last 10 problems. They did not skip around like I noticed Group 1 doing. After they class was finished with the packet, the teacher decided to go over a few of the problem with the students. The students seemed to have a good understanding of the material and were actively participating in the class discussion.

Table 5 shows the main observations made during the two days of observations. The table also connects the observations with Crawford's and White's (2003) contextual teaching strategies as well as the three motives to use contextual learning environments.

Table 5

*Main Observations Made with Connections to Strategies and Motives*

	Contextual Setting	Traditional Setting	Connection to Contextual Teaching Strategies/Motives
Day 1- Experimental	<ul style="list-style-type: none"> <li>• Showed signs of excitement by being engaged in the task</li> <li>• Groups were asking questions with other groups</li> <li>• Showed signs of motivation by being able to relate to the experience</li> </ul>		<ul style="list-style-type: none"> <li>• Strategy of <i>relating</i> was used because they were learning a new concept with a real life situation in which they could relating to</li> <li>• Strategy of <i>cooperating</i> was used because groups were working with other groups</li> <li>• Students were motivated by the learning because of the realistic situation</li> </ul>
Day 1- Control		<ul style="list-style-type: none"> <li>• Showed signs of restlessness</li> <li>• Lack of motivation</li> <li>• Became more involved in class discussion when doing the word problems</li> </ul>	<ul style="list-style-type: none"> <li>• Motive of math being realistic was evident when students were working on the word problems at the end of the lecture</li> </ul>
Day 2- Experimental		<ul style="list-style-type: none"> <li>• Not paying attention</li> <li>• Did not possess the same motivation from Day 1</li> <li>• Showed no effort</li> <li>• Completely opposite atmosphere</li> </ul>	

Table 5 (cont.)

<p>Day 2- Control</p>	<ul style="list-style-type: none"> <li>• Showed signs of excitement during opening activity</li> <li>• Showed signs of relating their own experiences to going to concerts with the math problems</li> <li>• Students worked together and shared ideas</li> </ul>		<ul style="list-style-type: none"> <li>• Strategy of <i>applying</i> was used because the students have already learned the material and now are applying the math to a real life situation</li> <li>• Strategy of <i>cooperating</i> was used by students working together</li> <li>• Motivation was evident by students really getting engaged in the task by relating their own experiences to the math</li> </ul>
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After reviewing the observations that were made from both days, I found that the order of instruction, learning in context before or after traditional instruction does not affect their attitudes toward learning. The main theme I noticed was that both groups were very motivated and engaged in the contextual lesson plan and were excited about learning the math in this type of setting. When students were learning the math in the traditional based lesson, they did not have the same reaction to the lesson as they did to the contextual lesson. They were not motivated and not interested in learning. The order of the instruction did not seem to affect their attitudes towards learning in anyway.

### Survey

On the third day of the study, the experimental and control groups filled out a survey (Appendix E) that asked them questions regarding the instruction they were given “today”.

The students were asked to modify those instructions and write about the instruction they received on Day 1; however, the teacher had asked them to write about the contextual lesson plan that both classes did. Therefore, the summary of the survey responses are reported together in Table 6 and about the contextual lesson only. The number in parentheses represents the number of students in both classes that gave that specific response

Table 6

*Responses from the Survey*

<p>1. Explain the approach method used in class today.</p>	<ul style="list-style-type: none"> <li>• Properties of equality (1)</li> <li>• Used a fun approach to learn 1 and 2 step equations and learned proper way to set up equations with variables. (4)</li> <li>• One and two-step equations (8)</li> <li>• Realistic settings to learn about solving and setting up equations (1)</li> <li>• Used a bunch of scenarios (13)</li> <li>• Used what we knew in a scenario that would be used in real life (5)</li> <li>• Interactive and gave a real world use to equations (2)</li> <li>• Read out loud with partners and solved problems using real life situations (3)</li> <li>• Read a story and different situations to solve one and two step equations (1)</li> <li>• Used a packet with person scenarios which was better than unrealistic problems (1)</li> <li>• The approach method used was more easy to relate to real life with a scenario and how to solve a problem (2)</li> </ul>
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Table 6 (cont.)

<p>2. Please list two things you liked about today's lesson and two things you didn't like.</p>	<p>Liked:</p> <ul style="list-style-type: none"> <li>• Interactive (1)</li> <li>• Make our own plan (4)</li> <li>• Work on their own with notes (1)</li> <li>• Work with a partner (16)</li> <li>• Like the theme (1)</li> <li>• Better than notes (4)</li> <li>• Real life events to solve the equations (4)</li> <li>• Helping each other by working in groups (1)</li> <li>• Going on own pace (2)</li> <li>• Scenarios (6)</li> <li>• More fun way to learn (9)</li> <li>• Compared to real life and good practice (2)</li> <li>• Items that I could relate to in the problems makes setting up equations easier (7)</li> <li>• Finding out what other people did (1)</li> <li>• Using more than just mathematics to solve problems (1)</li> <li>• Helped me create a 2 step equation (3)</li> <li>• Better than book work (1)</li> </ul>
	<p>Disliked:</p> <ul style="list-style-type: none"> <li>• The questions (8)</li> <li>• All the reading beforehand (10)</li> <li>• Reading it on my own. I like when the teacher stands in front of the class and explains how to solve the problems (1)</li> <li>• The problems were too easy (2)</li> <li>• Challenging problems (3)</li> <li>• Long (9)</li> <li>• Wanted larger groups (1)</li> <li>• Setting up the equations (2)</li> <li>• Had to do work (3)</li> </ul>

Table 6 (cont.)

<p>3. What did you learn in today's lesson?</p>	<ul style="list-style-type: none"> <li>• Dividing equations (2)</li> <li>• Properties and solve for a variable in an equation (1)</li> <li>• One and two step equations (24)</li> <li>• How we use math in real life (2)</li> <li>• How to do things by myself and not with a teacher (1)</li> <li>• Take scenarios and make equations to solve out of them (1)</li> <li>• How the real world applies to equations (1)</li> <li>• How to solve one and two step equations using real world problems (7)</li> <li>• What we are doing in math has something to do with something that could happen to me (1)</li> <li>• How to manage money using equations (3)</li> </ul>
<p>4. How could you improve this lesson for your own learning?</p>	<ul style="list-style-type: none"> <li>• Practice problems (6)</li> <li>• More challenging problems (5)</li> <li>• Teacher goes over the notes and explain before (2)</li> <li>• Good way to learn every so often (1)</li> <li>• Everything is fine (8)</li> <li>• Break down the reading (1)</li> <li>• Give more real life examples (9)</li> </ul>

The main theme from both groups' responses was the fact that they understood that they were using real life scenarios to which they relate to learn how to solve one and two step equations. Several students also said that they enjoyed working in groups and enjoyed the lesson more than taking notes. Another major response I saw when looking at what they would like to improve about the lesson was that they wanted to see more real life problems in the packet (See Table 7).

Table 7

*Summary of Key Topics from Survey*

- |                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Used real world problems to learn how to solve for one and two step equations (21)</li><li>• Enjoyed working with partners at their own pace (20)</li><li>• Using real life scenarios we can relate to (22)</li><li>• Wanted to see more real life problems (9)</li><li>• Enjoyed working at their own pace with partners (10)</li></ul> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

To summarize, the survey responses from both the experimental group and the control group show several similarities. For question 1, several students discussed how they used a real life scenario to learn about one and two step equations. These students were able to recognize that the mathematics being taught was being related to a real life situation that they can relate to. Other students discussed how the approach method was fun and interactive in learning about one and two step equations. In Question 2, a common response was the issue of working in groups and working at their own pace. These students enjoyed learning the math on their own and helping others without the teacher lecturing. Other students commented that they enjoyed working with real life scenarios because they could relate to them and it made the learning a more enjoyable lesson. Some of the “dislike” comments that the students said pertained to the amount of reading that was involved in the activity. Some of the students discussed how there was too much reading involved and only one student comment that he/she would have rather the teacher have taught them the lesson. This student said that they enjoy the teacher “standing in front of the room and teaching,” rather than working with a partner. Some thought that it was too easy while others that it was too challenging.

When asked what they learned from the lesson some students specifically explained about the math. They discussed that they learned how to solve and set up one and two step equations. Other students explained how they learned how to use math in real life by taking the scenarios they were given and setting up equations and solving for the equations. For Question 4, some students commented that one way to improve the lesson would for the teacher to go over the notes first with them instead of them doing it by themselves. One particular student commented that this approach method was good to “use every so often,” but not all the time, while other students said it was great and wouldn’t change anything.

It is evident to say that a majority of the students were able to understand that this activity helped them to learn mathematics through a real life situation. According to Crawford and White (2003), the contextual teaching strategy of relating was used in this lesson plan because the students are relating their experience of a night out on the town with learning about one and two step equations. The students actually used the word “relate” when discussing what they liked about the lesson by stating, “items in the problem that I can relate to help make setting up the equations easier.” Other responses showed evidence that the students enjoyed the activity and thought it made the learning process more enjoyable. Several of the students liked learning the math in groups and working at their own pace. Another student mentioned that they “liked to help each other by working in groups.” This comment agrees with Crawford’s and White’s (2006) teaching strategy of cooperating. Crawford and White (2006) declare that when students work in groups, they can often handle complex problems together with little outside help from the teacher. Overall, the responses from the survey give the impression that they enjoyed being able to relate the mathematics to

their own life experiences and that it made it easier and a more creative way to learn the math involved.

After analyzing the responses I received from the surveys, I found that the order of instruction does not affect students' attitudes towards learning. I did find out that students did have a positive reaction to the contextual lesson plan and did enjoy working with realistic problems. The students' responses give evidence that they were engaged in the learning by working with their peers on problems that they could relate to. With regards to the research question about students' attitudes toward learning, this data does not provide evidence that the order of the two instructions has an effect on their attitudes.

#### Quantitative and Exploratory Data Analysis Findings

In the final section of this chapter, I report on the data analyses derived from the pretest and posttest data. The following are the research questions that the statistical tests will help me answer:

1. How does the order of instruction, learning in context before or after traditional instruction, affect students' level of academic performance and their attitudes toward learning?
2. How does the order of instruction, learning in context before or after traditional instruction, affect different levels of academically ranked students' level of academic performance?

Before reporting on the analyses, I note that one student in the experimental group and one student in the control group were absent and did not participate in the study. This makes the experimental group have 21 students and the control have a total of 26 students.

In order to determine if there is a significant difference in the order of instruction, learning in context before or after traditional instruction, I first compared the individual improvement differences in scores from the pretest to posttest in both groups. Figure 3 shows the distribution of individual improvement differences in scores from the pretest to the posttest in the experimental group. The figure shows that the median is approximately 4 points. Figure 3 also shows that some students did not improve and in fact did worse. The upper quartile's value is approximately 6 points meaning that 25% of the class improved by more than 6 points and 75% of the class improved by less than 6 points. The lower quartile shows that 25% of the students improved by less than approximately 1 point while 75% of the class improved by more than 1 point.

*Figure 3.* Distribution of individual improvement differences for the experimental group

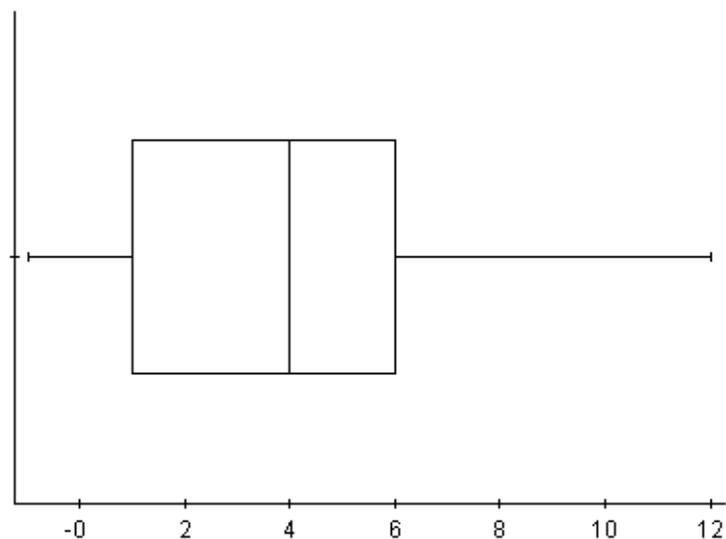
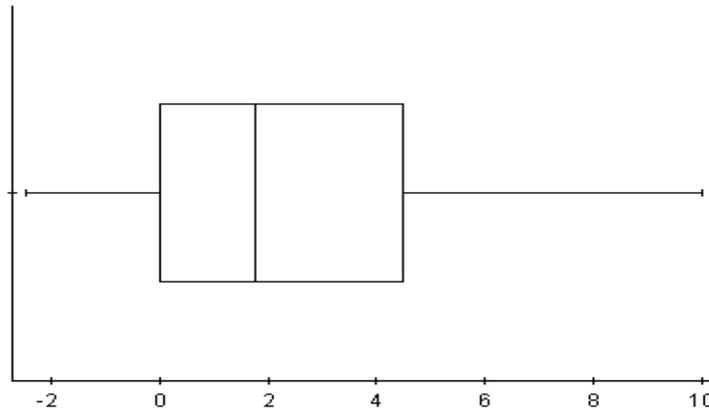


Figure 4 shows the distribution of individual improvement differences from the pretest to the posttest in the control group. The median is approximately 2 points. The lower quartile value is a zero, which means that 25% of the class improved by less than zero points and

75% of the class improved by more than zero points. The upper quartile value is approximately 4.5 points. This means that 25% of the class improved by more than 4.5 points and 75% of the class improved by less than 4.5 points.

*Figure 4.* Distribution of individual improvement differences for the control group



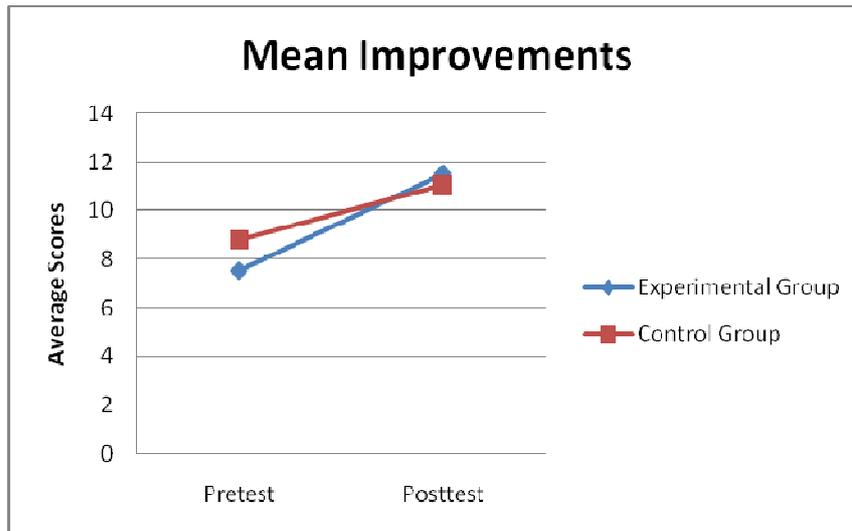
After analyzing the individual improvements from the pretest to the posttest in the two groups, I next evaluated the averages of the pretest and posttest scores from both groups. Table 7 shows that the experimental group did worse than the control group of the pretest, but did better than the control group on the posttest. This means that the experimental group improved more than the control group. Table 7 reports that the mean difference of improvement from the pretest to the posttest was higher in the experimental group by 1.71 points

Table 8

*Pretest and Posttest Averages from Both Classes*

	Pretest Average	Posttest Average	Mean Improvement
Experimental Group (1 <sup>st</sup> Period)	7.52	11.52	4
Control Group (2 <sup>nd</sup> Period)	8.76	11.08	2.29

Figure 5 shows that there is a larger improvement in the scores in the experimental group compared to the control group. In the methodology chapter, I reported that the pretest scores between the experimental group and the control group were not significantly different. With that said, these results appear to confirm that when students learn in a contextual setting first, they do better than the students who receive traditional instruction first, followed by contextual instruction second. These results also compliment Irwin's (2001) research study. Instead of looking at the differences between the two groups' averages of the pretest scores and posttest scores, Irwin looked at the mean percentage correct. Irwin (2001) found that all students who were working on contextualized problems in her study had a larger percentage increase in performance from pretest to posttest compared to the students who did not work on contextualized problems.



*Figure 5.* Mean improvements from the pretest to posttest of experimental and control groups

After comparing the mean improvements from the pretest to the posttest in both groups, I next conducted a t-Test to determine if there mean improvements showed a significant difference in teaching with the initial instruction of learning in a contextual setting compared to the initial instruction of traditional style teaching. I used the t-Test because the experiment fulfilled the requirements for using that particular method (see Chapter 3).

The following states my null hypothesis:

**Null Hypothesis:** There is no significant difference between the order of instruction of learning in contextual setting first then learning in a traditional setting compared to the reverse order.

Each test was conducted using a 2-tailed test because I did not know or predict a specific result direction for the study. The only hypothesis I made was that the performance would

change. The first t-Test I conducted was to see if there was a difference between the experimental group and the control group's means' of improvement between the pretest and posttest. I first found the difference between each student's pretest score and posttest score in each group. Then I found the average of these differences and used a t-Test to find out if there is a significant difference in the means of improvement. I first chose my level of significance, alpha level, to be 0 .05. The null hypothesis says that the means' of improvement are the same, while the alternative hypothesis declares them different. Table 9 shows the results.

Table 9

*Results of t-Test using 0.05 Level of Significance*

t-Test: Two-Sample Assuming Unequal Variances with alpha level 0.05		
	<i>Variable 1</i>	<i>Variable 2</i>
Mean	4	2.288461538
Variance	10.85	10.58346154
Observations	21	26
Hypothesized Mean Difference	0	
df	43	
t Stat	1.780803	
P(T<=t) two-tail	0.08201	
t Critical two-tail	2.016692	

At a significance level of 0.05, I fail to reject the null hypothesis because our p-value of 0.08201 is greater than our alpha level. This means there is insufficient evidence to say that there is a difference between the levels of students' performance who received the treatment

of learning in a contextual setting first, then learning in a traditional setting compared to the students who did not receive the treatment and received the reverse order.

Since I noticed that the mean improvement for the experimental group was 4 points and the control group's mean of improvement was 2.29 points, I still felt that there might be some type of significant difference. I decided to do another t-Test at an alpha level at 0.10.

Using the same assumptions and hypothesis, Table 10 shows the results.

Table 10

*Results of t-Test using 0.10 Level of Significance*

t-Test: Two-Sample Assuming Unequal Variances with an alpha level 0.10		
	Variable	
	1	Variable 2
Mean	4	2.288461538
Variance	10.85	10.58346154
Observations	21	26
Hypothesized Mean Difference	0	
Df	43	
t Stat	1.780803	
P(T<=t) two-tail	0.08201	
t Critical two-tail	1.681071	

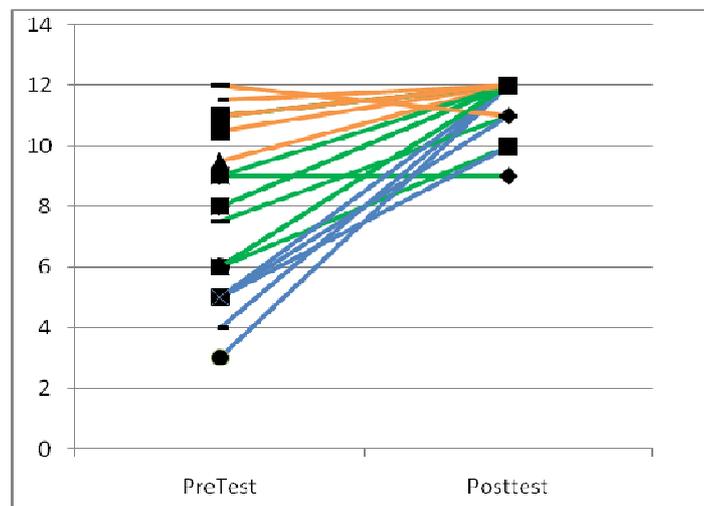
These results show that at an alpha level of .10, I reject the null hypothesis because the p-value of .08201 is less than our alpha level; therefore, at alpha level .10, there is sufficient evidence to say that there is a difference between the level of students' performance who received the treatment of learning in a contextual setting first, then learning in a traditional setting compared to the students who did not receive the treatment and received the reverse order, instruction in a contextual setting improved more.

Next, I more closely studied the individual differences of improvements from the pretest to the posttest in both groups. Figure 6 shows a line graph that matches each student's pretest score with their posttest score for the experimental group. Figure 7 shows a line graph that matches each student's pretest score with their posttest score for the control group. Table 11 describes what the colors of the lines represent in each figure. These results of the different levels of ranked students will be discussed later in the chapter.

Table 11

*Color Code Rankings for Figures 6 and 7*

Orange	Higher Ranked Student
Green	Middle Ranked Student
Blue	Lower Ranked Student



*Figure 6.* Experimental group's improvements from pretest to posttest

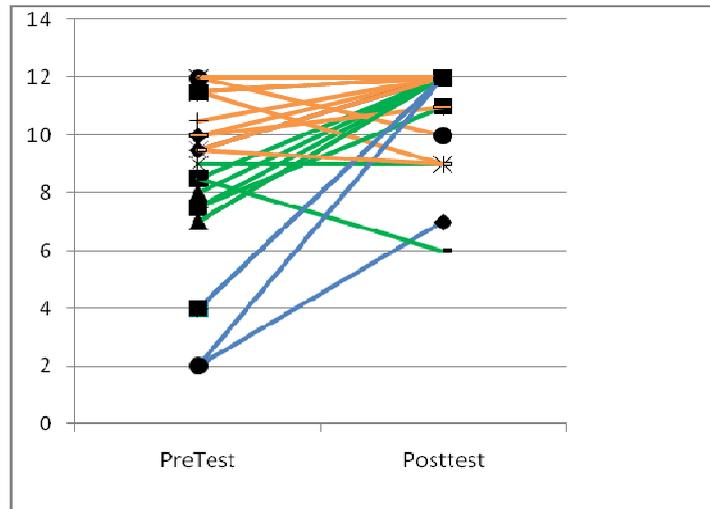


Figure 7. Control group's improvements from pretest to posttest

By looking at Figure 6 and Figure 7, it is evident that the control group had more students to go down in their scores from the pretest to the posttest. There are 4 students in the control who did not improve and only 2 students in the experimental group who did not improve. Also in the control group, 4 people scored the same on both tests and only 1 person in the experimental group stayed the same. It is evident that several students in both groups did improve.

The second part of the results section represents the results of the second research question.

2. How does the order of instruction, learning in context before or after traditional instruction, affect different levels of academically ranked students' level of academic performance?

While investigating the higher, middle, and lower ranked students, I first looked at how the higher ranked students performed in both the experimental and control groups.

Figure 8 shows the mean improvements from the pretest to posttest for the higher ranked students in both groups. The experimental group had a pretest average of 10.93 and a posttest average of 11.86. The control group had a pretest average of 10.96 and a posttest average of 11.36. The figure shows that that the students in the experimental performed more poorly on the pretest, but ended up doing better on the posttest than the control group. Both groups show signs of improvement, but the higher ranked students in the experimental group improved more than the control group.

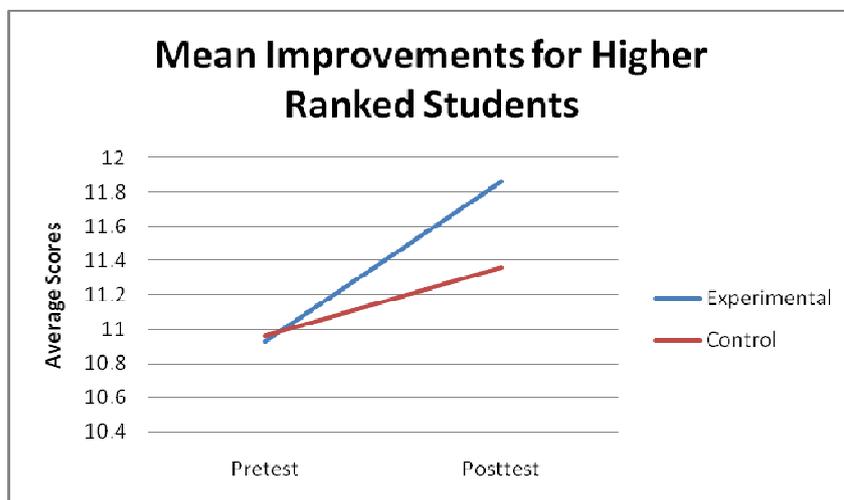


Figure 8. Mean improvements for higher ranked students

I next compared the middle ranked students in the experimental group to the middle ranked students in the control group. Figure 9 shows the mean improvements for middle ranked students in the experimental group and the control group. The middle ranked students in the experimental group had a pretest average of 7.44 and a posttest average of 11.25. The middle ranked students in the control group had a pretest average of 7.88 and a posttest average of 10.75. This data looks similar to the higher ranked students in the fact that both

groups did improve and that the middle ranked students in the experimental group did worse on the pretest, but still was able to improve more than the control group and even did better on the posttest.

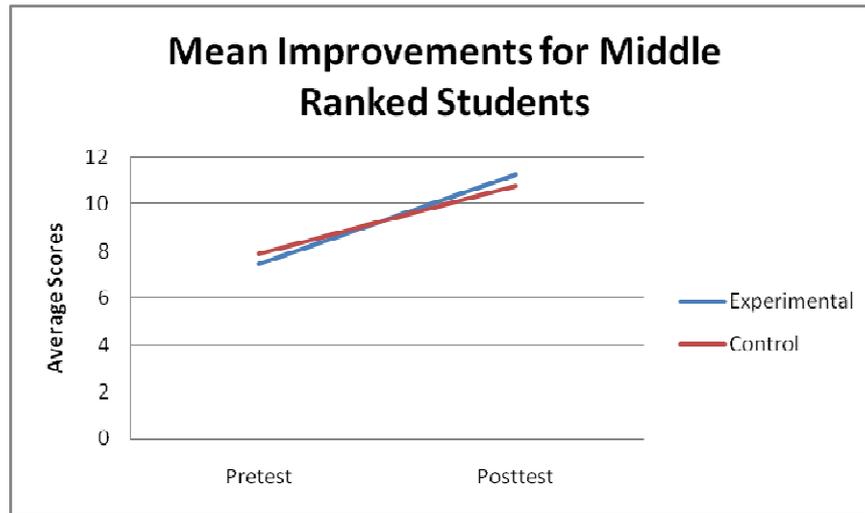


Figure 9. Mean improvements for middle ranked students

The last data that was analyzed was the mean improvements for the lower ranked students in the experimental group and the control group. The lower ranked students in the experimental group had a pretest average of 3.67 and a posttest average of 11.5. The lower ranked students in the control group had a pretest average of 3 and a posttest average of 10.75. It is evident that both groups did improve from the pretest to the posttest. Figure 10 shows that the lower ranked students in the experimental group did better on the pretest and posttest than the control group, but both groups improved the approximately the same amount.

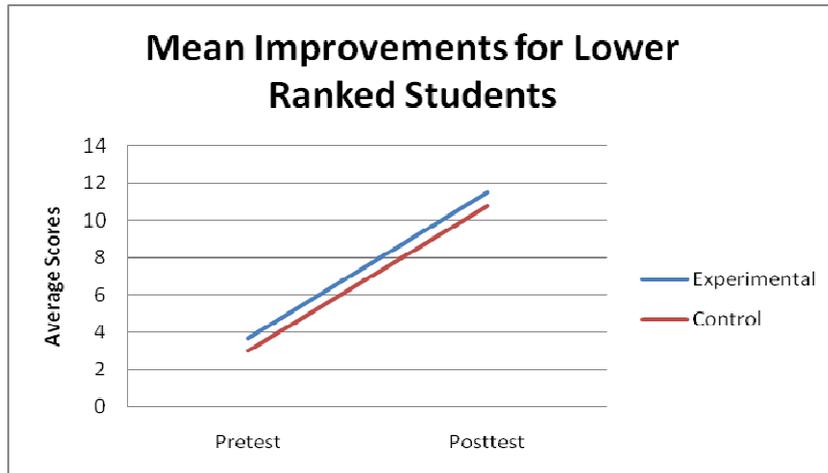


Figure 10. Mean improvements for lower ranked students

In Irwin's (2001) study, her results also showed that the improvement of the mean percentage correct was larger for both higher and lower ranked students who solved contextualized problems compared with those who worked with noncontextual problems. Her study also showed improvement from the pretest to posttest with higher ranked and lower ranked students who did not solve contextualized problems, which confirms my results.

The overall results helped me to provide answers to both of my research questions. The qualitative data was unable to show that the order of the two instructions affected students' attitudes towards learning; however, they did show that students were engaged in the contextual lesson plan and enjoyed the different components of it. The quantitative and exploratory data analysis show that students who received the contextual lesson plan first, followed by the traditional lesson plan, improved more from the pretest to the posttest than the control group who received the reverse order of instruction. The results are also able to show more students actually went down in their scores from the pretest to posttest in the

control group compared to the experimental group. These results also give evidence that the higher, middle, and lower ranked students in the experimental group, all improved more than those in the control group and also they all did better on the posttest.

## CHAPTER 5

### DISSCUSSION AND CONCLUSION

Earlier research has shown that learning in a contextual setting does provide benefits for students in the mathematics classroom. In this thesis, I proposed that there are three motives that enhance students' academic performance and attitudes toward learning when placed in a contextual setting. These motives include promoting motivation within the classroom (Gravemeijer and Doorman, 1999), allowing students to see the math in realistic settings (Hough and Gough 2002, Heuvel-Panhuizen 2007), and making the mathematics involved more meaningful to the students (Wubbels, Korthagen, and Broekman 1997, Sullivan, Zevenbergen, and Mousley, 2003.) The results from this thesis study show that the order of instruction when learning in a contextual setting versus learning in a traditional setting, does affect students' performance. This final chapter includes a summary discussion, along with limitations to the study, future investigations, and implications for mathematics education researchers and teachers in the field.

#### Summary

The goal of this study was to investigate if the order of learning in a contextual setting first, then learning in a traditional setting, compared to this instruction reversed, affected students attitudes towards learning and their academic performance. Four pieces of data were collected which included observations, a survey, a pretest, and a posttest. Each piece of data helped me to conclude that learning in a contextual setting first, then learning in a traditional setting, does benefit students in the classroom by improving levels of academic performance.

The observations that I made during the study, allowed me to see that when the students were learning in a contextual setting they were clearly more motivated and interested in the learning than the control group. When the students were learning in the traditional setting, there were no signs of being interested in the lesson because a majority of the class was restless, not paying attention, or doing other things at their desk. Authors Middleton and Spanias (1999) state that the "decline in positive attitudes toward mathematics can be explained in part as functions of lack of teacher supportiveness and classroom environment" (p. 67). The observations allowed me to conclude that the teacher always upheld a supportive role towards her students, but it was the environment of the classroom that allowed for the students learning first in a traditional setting to be disinterested in the math.

The survey (Appendix E) results gave me more feedback on how the students responded to the contextual lesson. Students commented that the contextual lesson was used to learn how to solve one and two step equations using realistic settings. I thought that this response was compelling because it meant that the students were understanding that the math they learned that day was placed in a setting that students could actually relate to and see the math in a realistic point of view. This is the premise for Realistic Mathematics Education. When students are able to see the math in a realistic setting, it helps them to not only relate to the material, but the math is able to make sense to them as well. Heuvel-Panhuizen states that "In RME, students should learn mathematics by developing and applying mathematical concepts and tools in daily-life problem situations that make sense to them (Heuvel-Panhuizen, 2003, p. 8.). The results from the survey show evidence that the students enjoyed

the learning in the contextual setting because it was fun to them, they enjoyed being able to relate to the math, and it was a better classroom environment over all that gave them positive attitudes towards the learning.

The improvements in scores from the pretest (Appendix C) to posttest (Appendix D) were analyzed to determine if there was a significant difference in the scores when comparing the order of the two instructions. With the t-Test, results showed that at an alpha level of 0.10, there is a significant difference in the mean individual improvements from the pretest to the posttest for the two classes. Therefore I report with 90% confidence that the students who received the treatment of instruction in a contextual setting first, then the traditional setting, improved more.

The second analysis that was done was looking at the improvements from the pretest to the posttest in both groups. This data was able to show that more students in the control group went down in their scores from the pretest to the posttest compared to the experimental group. The data also showed that more students kept the same score in the control group, and only one student in the experimental group stayed the same. The next analysis that was done was looking at the pretest and posttest average scores. The data shows that the mean improvement was higher in the experimental group than the control group.

The second research question investigated if there was a difference in the level of students' performance in higher, middle, and lower ranked students who received the treatment and those who did not receive the treatment. The mean improvements from the higher, middle, and lower level students, who received the treatment, showed that their increase in performance was larger than those who did not receive the treatment. The results

also showed that higher, middle, and lower level students who received the treatment both increased in their performance level from the pretest to posttest.

### Limitations

One limitation I found for this study is the issue of sample size and length of the study. This study only consisted of 48 students within a three day period. The reason for this sample is due to the accessibility I had with the teacher. The teacher I worked with for this study had two rather small algebra I classes compared to others. The length of the study was in consideration of the teacher's demands as well. The teacher felt comfortable with the three day study because in her syllabus, she had allotted at least two days for the study of one and two step equations to be implemented. If the study had the opportunity to be longer and have a larger sample size, the data might have produced more significant results.

I also think improvement on the pretest and posttest might provide more information. The tests were graded on points, and it was impossible to distinguish what students were really thinking about the mathematics. More open ended questions would have provided more descriptive results about the experiment.

### Future Investigations

In the future, I would like to have a larger and longer study that imitates this one. This study would still have the two groups of experimental and control. The experimental would receive the treatment of having the contextual lesson plan first, then the traditional lesson plan everyday for a whole chapter. The control group would not receive the treatment and would have the traditional teaching approach first, then the contextual lesson plan everyday for a whole chapter. This way, I could collect more data by obtaining more grades

such as homework grades, quiz grades and tests and conduct statistical tests to find out if there is a significant difference in the order of the two instructions. Having a larger sample size and carrying out the study for a longer period of time would hopefully give more promising and suitable results.

### Implications for Teachers

If teachers decide to have a classroom environment where students are learning in a contextual setting, they should make sure that the contexts is a situation or setting in which all the students are able to relate to. Decisions on the suitability of the contexts involved in the math should be of high importance if a teacher wishes to be successful in implementing tasks that create a contextual setting for the students. Research by Sullivan, Zevenbergen, and Mousley (2003) suggests that teachers should make careful judgments pertaining to the types of contexts they decide to use in their lessons (p. 108.) Inappropriate contexts can cause potential motivation to plummet, could have negative effects on the students, and could have the possibility to exclude some students Teachers should focus their attention on making the contexts real to the students. If the context in the problem pertains to an experience that a student will never have or is unfamiliar with, this will cause the student to be confused by the problem and will not understand the meaning behind the mathematics. Teachers should make the context in the problem familiar to the students and create experiences in which the students have had or might have later in life. This way, students are motivated by the problem because of the connection they have to it. Teachers should also be cautious of excluding students. When creating contextual problems, the problems should be able to address a wide range of students' interests and experiences. Failing to do so will

result in some students to become disinterested in the problem and will not learn the mathematics involved. In order to make sure a teacher is creating an appropriate context Sullivan, Zevenbergen, & Mousley 2003) state “choose a context that is relevant to both the problem content and the children’s experience, and have strategies for making the use of the context clear and explicit to the students” (p. 111).

The role of context problems in today’s teaching seems to be limited. Gravemeijer and Doorman (1999) explain that context problems often serve as an add on at the end of a lesson (p. 111). One suggestion for teachers who would like to implement contextualized problems more in their classroom would be for them to integrate contextualized problems in their lesson plans and not just add them on at the end. Realistic Mathematics Education supports this type of instruction by implementing contextualized problems at the beginning of the lesson and throughout. Research by Hough and Gough (2007) suggests that Realistic Mathematics Education allows for context problems to be used as “both a starting point and the medium through which pupils develop understanding” (p. 34). Having contextualized problems at the start of a lesson promotes motivation with the students. Gravemeijer and Doorman (1999) explain that in Realistic Mathematics Education context problems are implemented from the start onwards (p. 111). This type of instruction encourages motivation for the students because the math is evolved around a realistic situation that can be experientially real to the students.

The results of this research can make a difference for teachers of Algebra. Further work is needed, but hopefully the next few years will bring more changes toward teaching in a contextual setting.

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## **APPENDICES**

## Appendix A: Contextual Lesson Plan

### Friday Night out on the Town!

It is finally Friday and you and your friends are planning on going out for a fun night on the town. There is a concert that you and your friends have been looking forward to hearing for a month now and are excited to go listen to them. Your night will not only consist on going to the concert because your parents each gave you \$200 dollars to spend for the night and told you that you could keep the change you had left at the end of the night. Discuss with your partner all the options there are to do on your Friday night before and after the concert including how much these options will cost.

### Friday night out on the Town!

It is Friday night and you and 4 of your friends have each been given \$200 dollars to go out on the town to a concert. Your parents and your friends' parents all told you guys that you are allowed to keep the remaining amount of the \$200 dollars after the night is over. After you picked up all of your friends, you all decided that you wanted to go eat dinner before the concert. On the way to the concert there are 3 possible restaurants you can choose from. There is a McDonalds, a Wendy's, and a pizza parlor you and your friends can eat at. After you eat dinner, you continue your drive to the concert and realize that there are two ways you can get to the concert. One way is a short cut but you have to go through a toll booth and pay a fee. The second way is 2 miles longer, but you do not pass through the toll booth. After making the decision on which way to go, you and your friends finally get to the concert, but realize you have to pay to park in the parking lot. Once you and your friends paid to park and parked your car, you walked up to the ticket booth for the concert and realized that there are actually 4 bands that are playing at this concert tonight. Two of the bands are playing at 8:00 and the other two are playing at 9:00. Each ticket has a different price. After the concert, you and your friends are not ready to go home yet and decide to stop to get some ice cream at a local ice cream parlor. Once you and your friends have finished the ice cream, it is now time to go home.

### Prices for the Night's Options

#### McDonalds' Menu

Big Mac	\$3.50
Double Cheeseburger	\$2.25
Fries	\$1.00
Chicken Nuggets	\$4.50
Soft Drink	\$1.00
Bottle Water	\$1.50

#### Wendy's Menu

Jr. Bacon Cheeseburger	\$1.50
Chicken Sandwich	\$4.25
Fries	\$1.00
Chicken Wrap	\$2.25
Frosty	\$1.00
Soft Drink	\$1.00

#### Pizza Parlor's Menu

1 slice of pizza	\$3.50
Medium pizza (10 slices)	\$15.00
Toppings	\$0.50 each
Soft Drink	\$2.25

#### Concert Tickets

Band 1 @ 8:00	\$25.00
Band 2 @ 8:00	\$30.00
Band 3 @ 9:00	\$37.00
Band 4 @ 9:00	\$45.00

#### Ice Cream Parlor

Single Scoop	\$2.50
Double Scoop	\$3.25
Banana Split	\$3.00
Toppings	\$0.25 each

**Other Expenses**

Pay to Park	\$7.00
Toll Booth	\$2.00
Gas	\$0.75 per mile

Before we start solving for different scenarios of your night out, let's first learn how to set up and solve a one step equation.

Let's look at an example:

Example 1: You and your friends decided to go to McDonalds, and you purchased a Big Mac, a fry, and a soft drink. After you paid for your meal, the employer gave you \$15.00 back. How much money did you give the employee?

The first step in solving this problem is to first add up the amount of your purchase.  
Big Mac + Fries + Soft Drink =?

Now you should look at the menu prices and plug in the correct values that correspond to the purchases. This will give us:

$$3.50 + 1.00 + 1.00 = 5.50$$

In order to set up our equation, we first have to understand what values go where. Since we receive \$15.00, our equation will equal this value. Since we are trying to figure out what money we gave the employee, we are going to call this our variable. We say: Let  $b$  = money given to employer. We know that we spent \$5.50, so if we subtract this value from our variable,  $b$ , then this will equal the amount of change we received back. We have the following:

$$b - 5.50 = 15.00$$

We have now just set up our equation! Using the addition property of equality, we are going to add 5.50 to each side of the equation to get the variable alone on one side of the equal sign. The addition property of equality says for every real number  $a$ ,  $b$ , and  $c$ , if  $a = b$ , then  $a + c = b + c$ . For example:

$$9 = 4+5, \text{ so } 9 +3 = 4 + 5 + 3$$

Back to our example.

$$b - 5.50 + 5.50 = 15.00 + 5.50$$

On the left side of the equation, if we subtract 5.50 and then add 5.50, we get 0 because the two values cancel out. On the right side we are left with just  $b$ . Now we just have to add  $15.00 + 5.50$  and we get:

$$b = 20.50$$

At McDonalds, you gave the employer \$20.50.

Try one on your own.

$$\text{Solve: } x - 13 = 17$$

Ask your teacher for the answer or your partner!

Example 2: Once you and your friends get to the concert, you remembered that you owed one of your friends, so you kindly suggested that you would pay for his concert ticket. You and your friend decided to see the same concert. You spent a total of 70 dollars. Which concert did you see?

We first have to set up our equation like we did in example 1. Since you are paying for your ticket and your friend's ticket, you know that you are going to have to multiply the concert ticket price by 2. Since we do not know how much the ticket is because we are unsure which concert you decided to attend, we will let  $x$  be our variable. We write: Let  $x$  = price of one concert ticket. We know we spent a total of 70 dollars, so our equation must equal 70. Let's put this into our equation.

$$2x = 70$$

We have now set up our equation. The goal of solving the equation is to get the variable alone. In order to do that, in this case, we can divide 2 by both sides to get  $x$  by itself. This is called the division property of equality. The division property of equality says that for every real number  $a$ ,  $b$ , and  $c$ , if  $a=b$ , then  $\frac{a}{c} = \frac{b}{c}$ . For example:

$$5+1 = 6 \text{ so, } \frac{5+1}{2} = \frac{6}{2}$$

Back to our example:

$$\frac{2x}{2} = \frac{70}{2}$$

Once we divide 2 by both sides, we now have x by itself because 2 divided by 2 is one. On the right side, we need to divide 70 by 2 to get 35.

$$\frac{2x}{2} = \frac{70}{2}$$

$$x = 35$$

Therefore,  $x = 35$ , which means you and your friend paid 35 dollars.

Which band did you see?

Practice a problem on your own.

Solve:  $4y = 52$

Ask your teacher or partner for the correct answer!

Example 3:

At Wendy's, you ordered a Jr. Bacon Cheeseburger and a frosty. You told your friend that you would buy their dinner as well because you owed them money. If you spent \$6.75, what item did your friend have for dinner?

The first step in solving this problem is to find the total you spent on your order.

***Jr. Bacon Cheeseburger + Frosty = ?***

Now you should look at the menu prices and plug in the correct values that correspond to the purchases. This will give us:

$$1.50 + 1.00 = 2.50$$

In order to set up our equation, we first have to understand what values go where. Since you spent a total of \$6.75, our equation will equal this value. Since we are trying to figure out what your friend ordered for dinner, we are going to call this our variable. We say: Let  $d$  = friend's order. We know that your order was 2.50 so if we add this value to our variable,  $d$ , then this will equal the total amount of money you spent at Wendy's. We have the following:

$$d + 2.50 = 6.75$$

We have now just set up our equation! Using the subtraction property of equality, we are going to subtract 2.50 from each side of the equation to get the variable alone on one side of the equal sign. The subtraction property of equality says for every real number  $a$ ,  $b$ , and  $c$ , if  $a=b$ , then  $a - c = b - c$ . For example:

$$9 = 4 + 5, \text{ so } 9 - 3 = 4 + 5 - 3$$

Back to our problem:

$$d + 2.50 - 2.50 = 6.75 - 2.50$$

On the left side of the equation, since we subtracted 2.50 from 2.50 we get 0 because these two values canceled. We are now left with just  $d$  on the left side. On the right side of the equation, if we subtract 2.50 from 6.75, we get 4.25. Therefore,  $d = 4.25$ .

What did your friend eat for dinner?

Practice one on your own.

Solve:  $y + 23 = 31$

Ask your teacher or partner for the correct answer!

From the two previous examples, we have set up and solved one-step equations.

Example 3: After dinner, you and your friends continued your drive to the concert and decided to go the path that makes you go through the toll booth. One of your friends said that he would pay for the gas mileage from the restaurant you just ate at to the concert, plus the rate of the toll booth. If your friend ended up paying \$17.00, how many miles was the restaurant to the concert?

We first want to set up our equation. We know that it costs us \$0.75 per mile and an additional \$2.00 to go through the toll booth. Since we do not know how many miles were driven,  $m$  will be our variable. How would we write that?

We want to multiply  $m$  by 0.75 because for every mile that is driven, it costs \$0.75. Our equation is as follows:

$$0.75m + 2 = 17$$

How is this problem different than the other three?

In order to do this, we first have to apply the subtraction property of equality and subtract 2 from both sides of the equation.

$$0.75m + 2 - 2 = 17 - 2$$

After subtracting 2 from both sides we will have:

$$0.75m = 15$$

Our second step to the equation is to apply the division property of equality. Now this equation is similar to example 2. If you remember in example 2, to get the variable by itself, we applied the division property of equality. In this equation, we will apply the same property and divide both sides by 0.75.

$$\frac{0.75m}{0.75} = \frac{15}{0.75}$$

After dividing both sides by 0.75, we should get:

$$m = 20$$

The ride from the restaurant to the concert was 20 miles.

The kind of problem you just solved is called a two step equation. Try one for yourself.

Solve:  $12x + 7 = 43$

Ask your teacher or partner for the correct answer!

Now that you have learned about one and two step equations, you and your partner will solve the following problems that involve your Friday night out. Each problem is a separate

scenario, meaning that one problem does not depend on another. You will still be using the same prices listed above that you used in the previous examples. For each problem, set up the equation and solve the equation. If you can figure the answer out in a different way, you can use that to check if you did it correctly.

1. At the end of the night, you have  $x$  amount of dollars. Your friend pays you back for paying for the parking fee at the concert. After your friend gave you money, you had \$56. How much did you have before he repaid you?
2. You and your friends decided to eat at the pizza parlor. You decided to buy 2 slices of pizza. On one slice you didn't have a topping. On the second slice you decided you wanted toppings. You ended up spending \$9.50 on your pizza order. How many toppings did you order on your second slice of pizza?
3. After dinner, you have \$182 to spend. If you want to leave the concert with \$145, which concert ticket should you purchase?
4. At the pizza parlor, you ran into your rich Uncle Joe. Uncle Joe hands you a bunch of money and tells you to divide it evenly among you and your friends. Everyone receives \$26.50. How much money did Uncle Joe give you?
5. You decided to eat at Wendy's and ordered 2 chicken wraps, and another item. You spent a total of \$5.50. What was the other item you ordered?

6. After the concert, you and your friends went to get ice cream at the ice cream parlor. You decided to get a double scoop of chocolate with toppings. You remembered that you owed your friend money so you offered to buy his ice cream as well. He ordered a single scoop of strawberry. If your total was \$13.75, how many toppings did you get on your ice cream?
  
7. After dinner, you decided that you would pay for the expenses on the way to the concert, meaning gas and toll booth. After dinner you left with \$189.50 and arrived at the concert with \$179.25. If you paid for the gas and toll booth costs from dinner to the concert, how many miles did you drive?
  
8. At the concert, you and your friends decided to put money all together so that you could buy a CD that had all the songs from all four bands on it. If the CD costs \$33.75, how much money does each person have to give?
  
9. At McDonalds, you only want to spend \$6.75. If one of your items that you ordered was chicken nuggets, what other item did you purchase?

10. Once arriving to the concert, you purchased two concert tickets. Your friend realized that they could not afford a second ticket so you offered to buy theirs as long as it was the same concert as one of your tickets. You purchased a ticket for band 4 for your friend. What is the other concert ticket you purchased if you spent \$115?

2.1

1) Addition Property of Equality  
 For every real number  $a, b,$  and  $c,$  if  $a=b,$   
 then  $a+c=b+c.$

2) Subtraction Property of Equality  
 For every real number  $a, b,$  and  $c,$  if  $a=b,$   
 then  $a-c=b-c.$

3) Solve each equation.

a)  $x+5=6$

$x=1$

b)  $\frac{2}{3} + y = \frac{1}{4}$

$y = -\frac{2}{3} + \frac{1}{4}$

$y = -\frac{8}{12} + \frac{3}{12}$

$y = -\frac{5}{12}$

c)  $-18 = 6 + w$

$-24 = w$

d)  $b-5=7$

$b=12$

e)  $m-10=2$

$m=10$

f)  $y-7.6=4$

$y=11.6$

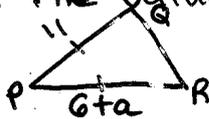
g)  $-9=b-5$

$b=-4$

h)  $-3+x=5$

$x=8$

1) Find the value of  $a.$



6) Together, you and your puppy weigh 128 lb. If you alone weigh 115 lb, how much does your puppy weigh?

6) Multiplication Property of Equality  
For every real number  $a$ ,  $b$ , and  $c$ , if  $a=b$ , then  $a \cdot c = b \cdot c$ .

7) Division Property of Equality  
For every real number  $a$ ,  $b$ , and  $c$ , with  $c \neq 0$ , if  $a=b$ , then  $\frac{a}{c} = \frac{b}{c}$ .

8) Solve each equation.

a)  $\frac{a}{6} = 5$

b)  $\frac{x}{-3} = 18$

c)  $-\frac{a}{5} = -20$

d)  $-\frac{t}{6} = -9.3$

e)  $\frac{2}{3}y = -10$

f)  $-\frac{1}{4}m = 8$

g)  $\frac{3}{8}p = -15$

h)  $\frac{x}{15} = \frac{2}{3}a$

i)  $6m = -42$

j)  $3a = 12$

k)  $20 = -2x$

l)  $-8 = 5y$

## 2.2

1) To solve two-step equations, get the term with the variable by itself by using addition or subtraction. Then multiply or divide to solve.

2) Solve each equation.

a)  $7 = 2y - 3$

$10 = 2y$  add. prop. equ.  
 $5 = y$  div. prop. =

b)  $6a + 2 = -8$

$6a = -10$  sub. prop. equ.  
 $a = -\frac{10}{6}$  div. prop. =

c)  $\frac{x}{9} - 15 = 12$

$\frac{x}{9} = 27$  add. prop. =  
 $x = 243$  mult. prop. =

d)  $13 = \frac{y}{3} + 5$

e)  $-x + 7 = 12$

$-x = 5$  sub. prop. =  
 $x = -5$  div. prop. =

f)  $-a - 5 = -8$

g)  $4 = -c + 11$

h)  $\frac{x-3}{2} = 7$

i)  $\frac{x+3}{-2} = 5$

$x+3 = -10$  mult. prop. =  
 $x = -13$  sub. prop. =

j) You order iris bulbs from a catalog. Iris bulbs cost \$0.90 each. The shipping charge is \$2.50. If you have \$18.50 to spend, how many iris bulbs can you order?

$0.90x + 2.50 = 18.50$

$0.90x = 16.00$

$x = 17.78 \rightarrow 17$  bulbs

1) Solve each equation. Justify each step.

a)  $\frac{3}{5}w + 9 = -1$

$$\frac{3}{5}w + 9 = -1$$

given

$$\frac{3}{5}w = -10$$

sub. prop =

$$3w = -50$$

mult. prop =

$$w = \frac{-50}{3}$$

div. prop =

b)  $-9 - 4m = 3$

given

$$-4m = 12$$

add. prop =

$$m = -3$$

div. prop =

c)  $8 = \frac{c}{24} + 4$

$$4 = \frac{c}{24}$$

sub. prop =

$$96 = c$$

mult. prop =

Appendix C: Pretest

1. Solve (2 points)

$$x + 15 = -9$$

$$x + 15 - 15 = -9 - 15 \quad 1 \text{ point}$$

$$x = -24 \quad 1 \text{ point}$$

Total points: 2

2. Solve (2 points)

$$\frac{7}{8}x = 14$$

$$(8)\frac{7}{8}x = 14(8) \quad 1 \text{ point}$$

$$7x = 112$$

$$\frac{7x}{7} = \frac{112}{7} \quad 1/2 \text{ point}$$

$$x = 16 \quad \frac{1}{2} \text{ point}$$

Total points: 2

3. Solve (2 points)

$$12 = \frac{n}{8} + 10$$

$$12 - 10 = \frac{n}{8} + 10 - 10 \quad \frac{1}{2} \text{ point}$$

$$2 = \frac{n}{8}$$

$$2 * 8 = \frac{n}{8} * 8 \quad 1 \text{ point}$$

$$16 = n$$

1/2 point

Total points: 2

4. You have  $x$  dollars and your friend pays you back the 9 dollars he owes you. You know have 14 dollars. How much did you have before he paid you?

$$x + 9 = 14$$

1 point

$$x + 9 - 9 = 14 - 9$$

1 point

$$x = 5$$

1 point

Total points: 3

5. You are ordering tulip bulbs from a flowering catalog. The cost is .75 cents per bulb. You have \$17 to spend. If the shipping cost is \$2 for any size order, determine the number of bulbs you can order.

$$.75x + 2 = 17$$

1 point

$$.75x + 2 - 2 = 17 - 2$$

1/2 point

$$.75x = 15$$

$$\frac{.75x}{.75} = \frac{15}{.75}$$

1/2 point

$$x = 20$$

1 point

Total points: 3

Appendix D: Posttest

1. Solve (2 points)

$$8 + y = 23$$

$$8 - 8 + y = 23 - 8 \quad 1 \text{ point}$$

$$y = 15 \quad 1 \text{ point}$$

Total points: 2

2. Solve (2 points)

$$\frac{8}{15}x = 4$$

$$15 * \frac{8}{15}x = 4 * 15 \quad 1 \text{ point}$$

$$8x = 60$$

$$\frac{8x}{8} = \frac{60}{8} \quad 1/2 \text{ point}$$

$$x = 7.5 \quad \frac{1}{2} \text{ point}$$

Total points: 2

3. Solve (2 points)

$$22 = 5x - 13$$

$$22 + 13 = 5x - 13 + 13 \quad 1 \text{ point}$$

$$35 = 5x$$

$$\frac{35}{5} = \frac{5x}{5} \quad \frac{1}{2} \text{ point}$$

$$7 = x \quad \frac{1}{2} \text{ point}$$

Total points: 2

4. Your school's athletic program is having a bake sale. They have \$20 dollars to make change for the customers. At the end of the sale, they have \$175.50. How much money did they make?

$$x + 20 = 175.50 \quad 1 \text{ point}$$

$$x + 20 - 20 = 175.50 - 20 \quad 1 \text{ point}$$

$$x = 155.50 \quad 1 \text{ point}$$

Total points: 3

5. The rate to rent a certain truck is \$55 per day and \$0.20 per mile. Your family pays \$80 to rent this truck for one day. How many miles did your family drive?

$$0.20x + 55 = 80 \quad 1 \text{ point}$$

$$.20x + 55 - 55 = 80 - 55 \quad 1 \text{ point}$$

$$.20x = 25$$

$$\frac{.20x}{.20} = \frac{25}{.20} \quad 1/2 \text{ point}$$

$$x = 125 \quad \frac{1}{2} \text{ point}$$

Total points: 3

## Appendix E: Survey

### Survey on Solving One and Two Step Equations

1. Explain the approach method used in class today.
2. Please list two things you liked about today's lesson and two things you didn't like.
3. What did you learn in today's lesson?
4. What was your last math course you had?
5. What science class are you in or what science class did you just complete?
6. How could you improve this lesson for your own learning?

## Appendix F: IRB Submission

North Carolina State University is a land-grant university and a constituent institution of The University of North Carolina

### Office of Research and Graduate Studies

**NC STATE UNIVERSITY**

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From: Joseph Rabiega, IRB Coordinator

North Carolina State University  
Institutional Review Board

Date: September 8, 2008

Project Title: Investigating the Difference in the Order of Teaching with a Context and Teaching without a Context

IRB#: 338-08-9

Dear Ms. Holland:

The research proposal named above has received administrative review and has been approved as exempt from the policy as outlined in the Code of Federal Regulations (Exemption: 46.101.b.1). Provided that the only participation of the subjects is as described in the proposal narrative, this project is exempt from further review.

#### NOTE:

1. This committee complies with requirements found in Title 45 part 46 of The Code of Federal Regulations. For NCSU projects, the Assurance Number is: FWA00003429.
2. Any changes to the research must be submitted and approved by the IRB prior to implementation.
3. If any unanticipated problems occur, they must be reported to the IRB office within 5 business days.

Please provide a copy of this letter to your faculty advisor.

Sincerely,

Joseph Rabiega  
NCSU IRB