THE EFFECTS OF PROJECT-BASED LEARNING ACTIVITIES ON ACADEMIC ACHIEVEMENT AND MOTIVATION IN MATHEMATICS IN EIGHTH-GRADE STUDENTS

A Dissertation

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by
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This dissertation is dedicated in honor of my family. Especially to my parents, Barry and Karen Jenkins, my husband Jonathan Mudrich, and my children, Stetson and Shiloh for all their determination and sacrifices made to ensure the accomplishment of my educational and life goals. I hope through this, I can show them that anything is possible, and that I made them proud.

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List of Abbreviations

ALSDE – Alabama Department of Education

CCRS – Common Core Readiness Standards

ELA – English/Language Arts

MCPSS – Mobile County Public School System

MSLQ – Motivated Strategies for Learning Questionnaire

NAEP – National Assessment of Educational Progress

PBLA – Project-based Learning Activities

PISA – Program for International Student Assessment

SASS – Schools and Staffing Survey

Abstract

Mudrich, Rachel Marie, Ph.D., University of South Alabama, May 2017. The Effects of Project-Based Learning Activities on Academic Achievement and Motivation in Mathematics in Eighth-Grade Students. Chair of Committee: Brenda C. Litchfield, Ph.D.

The purpose of this research study was to determine if project-based learning activities (PBLA) incorporated into an eighth-grade mathematics classroom have an effect on students' academic achievement and motivation toward learning. The control group used the traditional instruction method to cover mathematic objective skills that are Common Core Readiness Standards (CCRS), Alabama State Department of Education (ALSDE), and Mobile County Public School System (MCPSS) aligned. The treatment group covered the same skills using the project-based learning activities teaching method. A pretest and posttest were given, and the data compared and analyzed to determine if a significant difference existed in the mathematics achievement scores of the groups using the two instructional teaching methods. A pre and post questionnaire on mathematics motivation was given, and the data were compared and analyzed to see if there was a significant difference between students' perceptions and motivation toward learning mathematics before and after the treatment period. There were a total of 124 student participants in this study divided into two groups of 62 students. The students attended a rural middle school, consisting of a range of ages, abilities, and races. Pretest and posttest scores on the mathematics skills test, weekly standards-based lesson plans,

and pre and post Motivated Strategies for Learning Questionnaire (MSLQ) mathematics motivation scores were collected. Statistical analyses found no overall statistically significant difference in mathematics achievement between groups. When looking at achievement results, it was found that the PBLA group had a higher mean than the traditional group, but not enough to make it statistically significant. When the data were compared to look at the difference in mathematics motivation between the control and treatment groups, it was found that there was an increase in the motivation level of the treatment group. This increase, however, was not enough to be statistically significant. Therefore, there was also no statistically significant difference in mathematics motivation between the treatment and control groups. Data were analyzed and discussed, with future plans for further study on this topic.

Chapter I - Introduction

Introduction

From the moment people are born into this world, they begin to learn. Newborns learn how to get necessities through crying and moving. As they develop into toddlers, newborns learn by exploring through their senses: seeing, smelling, hearing, tasting, and touching. As they grow, children are constantly exploring the world around them through an active, hands-on learning approach, so that they can develop their knowledge base. Jean Piaget made it his life's research to develop an understanding of how people, specifically children, learn. Piaget believed that a child develops through a continuous transitioning and building of thought processes (Piaget, 1952). Piaget labeled these transitions as four major stages of cognitive development that children go through as they mature into adults. One of his developmental stages consists of a period of months or years, and signifies when development takes place (Piaget, 1952). The stages make apparent the constructivist mindset that a child learner has, as each aspect of their growth and development centers on active learning to gain knowledge.

Stages of Development and Active Learning

Piaget broke down his constructivist viewpoint of learning as follows, to provide a guidance to active learning as it starts from birth. A visual display of these four stages is displayed in Table 1.

Table 1

Piaget's Theory of Cognitive Development Stages

Sensorimotor Stage Ages: 0 - 2	Preoperational Stage Ages: 2 - 7
-Identifies object performance; the object still exists when it is out of sight -Recognition of ability to control object and acts intentionally	-Begins to use language -Egocentric thinking: difficulty seeing others viewpoints -Classifies objects by single feature (i.e., color, size)
Concrete Operational Stage Ages: 7 - 12	**Formal Operational Stage Ages: 12 - adult**
-Logical thinking -Recognizes conservation of numbers, mass and weight -Classifies objects by several features and can place them in order	-Logical thinking about abstract propositions -Concerned with the hypothetical and the future -Create hypotheses and tests

Note. These are the stages at which a child develops and grows.

The sensorimotor stage is the first of the cognitive development stages identified by Piaget. This stage is active between the ages of 0-2 years, and it is during this stage that children develop skills and knowledge by interacting with their environment (Piaget, 1952). During these years, infants are constantly using their five senses to associate things in their environment and build a knowledge base for themselves. It is truly remarkable how curious humans are, even from birth; you can almost see the desire for knowledge within the face of every child. The second stage of cognitive development is the preoperational stage that is active between the ages of 2-7 years. During this stage, children are becoming more and more inquisitive about their environment. They are getting into everything to try and make sense of it all, and asking a thousand questions to whoever will stop long enough to listen to them. This stage also brings about an increase in language ability and symbolic representations (Piaget, 1952). Children are learning how to talk, develop words, read independently, and recognize symbols with meanings in their surroundings (Piaget, 1952). Again we see that the more active and involving the learning process is, the more children will learn in this stage.

The concrete operational stage is the third stage of growth for children in Piaget's theory. This stage is active from ages 7-12 years. This stage begins to provide structure to the knowledge that the children have built up in their memories. It brings about organization of thoughts and learning, rules and how to follow them, and basic structure (Piaget, 1952). The final stage in Piaget's cognitive development theory is the formal operational stage, spanning across ages 12-adulthood. In this stage, children are able to move past the concrete into the more abstract in thinking for the future (Piaget, 1952). This last stage is also the stage that brings about the connections in learning between the knowledge that children have, and performance-based scenarios that allow them to apply that knowledge. The common thread we see here in these stages and throughout Piaget's work, is that as children grow, they are constantly hands-on in their learning process. It is a human instinct to learn the way we do, at the rate we do. If children know to learn in an active, hands-on manner from birth, without any formal training, it is only natural to continue to nurture and encourage this learning style within the educational systems.

Social Constructivism, Cooperative Learning, and Project-Based Learning

As Piaget made the case for children learning though active environment stages, Lev Vygotsky made his emphasis in psychology through researching and development of the social aspect of constructivist learning. According to Vygotsky (1978), the sociocultural environment surrounding a child presents the child with a variety of tasks and demands. These tasks require the child to interact to problem solve, and engages the child in the environment to learn through the attempt to accomplish these tasks. Vygotsky (1978) states that children acquire knowledge through contacts and interactions with people and experiences, then later assimilate and internalize this knowledge, while adding their personal value to the knowledge gained.

This transition from social to personal property, according to Vygotsky (1978), is not a copy, but a transformation into personal value which has been learned by the child. Vygotsky (1978) claims that this is what also happens in schools. As he claims, students do not just copy teachers' capabilities; rather they transform what teachers offer them as knowledge and during the processes of knowledge adoption into their memory. This social aspect of learning from Vygotsky, combined with the active learning concepts from Piaget, withstand the test of time as a strong foundation upon which to build a child's knowledge base for lifelong learning.

Socialization in learning is almost unavoidable. From the time of birth, humans are taught to be social. Mothers, fathers, and other family members spend time with children, teaching them to become self-sufficient through socialization (Lerner & Ciervo, 2004). Yet when children enter elementary school, this knowledge base of social nature and its benefits often are disregarded. The scene of a typical, present-day school classroom is students seated in individual desks, placed in rows, where the expectation is to sit quietly during lessons. Daily lessons consist of a teacher giving direct instruction to the whole group, where students are expected to absorb the instruction, like sponges. In this type of class setting, often the only interaction encouraged is between teacher and student. When this form of direct instruction happens, students become passive recipients of knowledge and resort to rote learning (Zakaria & Iksan, 2007). In this scenario, the benefits of the human social nature for knowledge acquisition have been lost. Children are expected to absorb all the information the teacher alone is imparting upon them, without being actively engaged in their own learning processes.

Suzie Boss expressed in her 2011 article that learning is something students do, not something that is done to students. As she pointed out, John Dewey noted that "Education is not preparation for life; education is life itself" (pg. 1). This statement reinforces the concept that students must play an active role in learning in order for true learning to take place. Learning, therefore, cannot be simply a spectator sport - students must become involved in the learning process (Johnson, Johnson, & Holubec, 2013). With a diverse classroom of students, all with their own personal learning style and life background, there is a slim chance for every student with their different ability levels to experience the desired learning interaction. This point is particularly valid when there is no motivation to learn within the classroom. The individual viewpoints each student possesses are rarely developed through lessons where they are not encouraged to share their thoughts with their classmates (Dahley, 1994). In many situations, a students' peers are often more attentive than the teacher of what their classmates do and do not understand. When allowed to work within the boundaries of a group, students tend to open up, help one another, and can often times provide help in a way that can be better understood by other students.

Two ideal goals of education for students are for students to grow and cultivate a deeper understanding of various subject matters, and to have the motivation to continue the learning beyond the classroom (Miller & Atkinson, 2001). Students' academic achievement can be influenced by school experiences when the learning environment is conducive to the learning objectives at hand (Nye, Hedges, & Konstantopoulos, 2001). Students’ motivation toward learning can also be influenced by the learning environment, as well as by their learning community around them, both in and out of school (Patrick, Ryan, & Kaplan, 2007). As noted in research, learning takes place both inside and outside of the classroom, at school and at home. This collaborative group approach in a core concept of a teaching method known as project-based learning that is working to bring more aspects of active learning back into the classroom. Cooperative learning through project based learning is widely believed to be a principal teaching strategy that can boost student motivation and draw the interest of students (Hmelo-Silver, 2004).

Cooperation among individuals is essential to the progress of the human civilization. It is as valuable to the functioning of families as it is to the relationships of individuals. Being able to work as an individual with others who are different from oneself is crucial to the success and encouraged diversity of the human population. Regardless of race, handicap, or ability, people should learn that it is best to work together for the common good (Artzt & Newman, 1997). In knowing this, it is essential to begin teaching the skills needed for cooperative learning during the developmental years of children. When students learn to cooperate and collaborate their ideas into one common goal to accomplish a task, the outcome of the task becomes so much more than just basic learning. When students take part in cooperative learning groups they start to consider others' ideas and viewpoints, they become responsible to others, and engage in critical thinking (Lillard, 2013). Furthermore, as they work together, they are actively engaged in the learning. Active involvement during the learning process allows students to discover material in a way that is contrary to traditional, passive lectures (Freeman, Alston, & Winborne, 2008). As stated, research has shown that students' do prefer to learn together as a group, rather than as an individual (Dat Tran, 2014). However, what happens if there is a group of students who have apparent differences within their learning process, threatening to shut down the cooperative learning altogether for this group?

Equipping Students in Education

The reality in education is that the students learn at different rates and by different methods. In education, it has been known for years that educators have struggled with how to accommodate the differences in individual students' backgrounds and learning styles (Zimmerman, 2002). Tomlinson (2009) explained finding two individuals the same age who learn the same way and on the same timetable is a rarity. As the population grows, so does the student population with the schools. As the definition of home and family change, so do the backgrounds from which students come into schools. Classrooms today have a diverse population of students within them. This diversity covers ages, races, economic status, class size, and student ability level. Classrooms today, thanks to mainstreaming and population growth, are larger in student size, than ever before. The National Center for Education Statistics, through the Schools and Staffing Survey (SASS), reported the average middle school class size in 2011-2012 is 28.4 students per class, which is higher than the national average of 25.5 students per class. These numbers have increased since the last SASS in 2007-2008, reporting Alabama at 24 students per class while the national average was at 23.3. As the number of students in the classroom increases, the overall ranges and abilities within the classroom increase. This increase in the range and abilities of classroom students has raised concern regarding the teacher's ability to cope with a classroom consisting of such a wide variety of learning styles (Tournaki, 2003). Reformers and educators have suggested various ways to adjust the curriculum to accommodate students' individual differences. Such adjustments include the grouping of students homogeneously according to age, gender, or ability; introducing perceptual-motor learning tasks; and broadening course work to include training in practical skills (Zimmerman, 2002). This incorporation of differentiated accommodations shifts the basis of what learning is from the traditional teacher-centered approach to the more current concept of a student-centered approach to learning (Sungar & Tekkaya, 2006). The latter approach allows the students to remain actively involved in the learning process, assume responsibility for the learning, and the ability to apply the skills into performance-based scenarios that will assist them in their future.

In preparing students for their future, today's education system must do more than simply teach; it must provide students with a classroom environment where they experience the exhilaration of understanding the world around them, and where in this world they can use appropriate scientific processes to make decisions (Sungur, Tekkaya, & Geban, 2006). Allowing the students to make their own decisions about which actions they should take to meet their goals makes their work increasingly meaningful. This application of meaning into their learning process encourages depth of understanding and motivation toward educational success (Pedersen & Williams, 2004).

Students who become motivated to learn and confident about their own abilities to make learning decisions, guide their own acts and shape their beliefs according to what they can do (Smith, Sansone, & White, 2007). Orhun (2013) stated, "Learning can be expressed as gathering information, processing information, the improvement of thinking, and the method of selection for attaining knowledge" (pg. 1159). Allowing students to make viable decisions about what they are learning and how they are learning it is a key component to effective learning (Owens & Straton, 1980). Learning preference is an aspect of how we learn, so knowing how students' want to gather the information and using that knowledge as a guide for the instruction is a benefit to a teacher. Learning preference is known as how a learner reacts towards learning experiences (Keefe, 1979). Effective learning is more than students being exposed to the material, it is their exposure, engagement, and reflection response for future growth. Mayer and Massa (2003) researched the aspect of learning preference, cognitive ability and cognitive style in learners. They found that a learner's preference of learning is an individualistic skill of those learners within a learning environment (Mayer & Massa, 2003). Mills and Angnakoon (2015) revealed that while studies on learning preferences have not lead to concrete evidence in regards to learning preferences and academic achievement, the research conducted by Orhun (2013) showed that a learners preferred learning style has the potential to be a tool for mathematic academic improvement.

Learning preference is relevant to this study, because it notes how students prefer to gain their knowledge and has been noted to be an indicator of academic achievement. Research supports that learning preference is connected to motivation for in and out-of-school learning (Hong and Milgram, 2000). By bringing learning preference into a position of importance, the students will notice their viewpoints being recognized in the learning process. When students feel respected, and are learning in ways that they prefer, they are more motivated to do the work and become actively involved in the process of knowledge development. Individual student responsibility for education then takes place, as the students guide their own learning processes, a key aspect of student-centered learning.

John McCarthy (2015) indicated in his online article that when the emphasis of classroom activities is directed at more student-led approaches and away from teacher-led approaches, learning tends to be more meaningful and effective. This is because the students are the ones who are generating what they need to advance their own skills, therefore they feel a sense of responsibility in the success or failure of the learning process. When students believe that they control important activities in the classroom, they will have greater motivation to put forth effort and to continue working on a given task (Cheng, Lam, & Chan, 2008). Students who freely choose their own learning activity are more likely to be engaged in a task, and become determined to see it through until the end, as well as be able to discuss the process as they feel invested into the learning process (Mills & Angnakoon, 2015). Performance-based learning projects and scenarios are a way to accomplish academic objectives, while allowing the students to still lead the learning. Projects and performance-based scenarios allow students to get hands-on in the learning, work together in collaborative groups, and make analytical decisions necessary to achieve a desired outcome. When the project approach takes hold in the classroom, students gain opportunities to engage in real-world problem solving too (Boss, 2011). A factor that is often overlooked in education, is the transfer of relevance from the classroom into the actual situations where that information would be needed.

To allow students to be able to engage in actual knowledge-based application situations would allow them to guide their instincts with their knowledge from start to finish, and reflect on the process for future learning. Performance-based scenarios also bring about a different way to observe and assess the skills of students, which also keeps them engaged and motivated, as they must stay active, social, and analytical throughout the process. Learning through projects is a way for students to flex their creative muscles, especially in the technological age of this century. Boss (2011) said through her article "especially when it is infused with technology, project-based learning may look and feel like a 21st-century idea, but it is built on a venerable foundation" (pg. 1).

Purpose of the Study

As education continues to change, it requires teachers to constantly work to develop inventive and effective teaching methods to keep up. These methods aim at increasing academic achievement and maintaining students' interest in their own learning. When educators use teaching methods that get the students actively involved in the learning process, more meaningful and higher-level learning will take place (Piaget, 1952). The purpose of this study is to incorporate the teaching method of project-based learning activities into middle school mathematics classrooms. This study was designed to see if the project-based learning form of active learning has a significant impact in the difference of eighth-grade student's academic achievement and motivation toward mathematics.

Statement of the Problem

As students in the United States progress through the educational system, they tend to perform lower on international math assessments (DeSilver, 2015). One of the biggest international tests given is the Program for International Student Assessment (PISA), which is administered every three years. This assessment measures reading, math and science literacy among 15-year-olds. The most recent PISA results from 2012 (Table 2), show while United States students are scoring higher on the national math assessments than they did two decades ago, they still are ranking in the 50 percentile on international comparisons. The United States ranked 35th and 27th out of 58 countries in math and science. Among the 34 members of the Organization for Economic Cooperation and Development, which sponsors the PISA initiative, the United States ranked 27th in math and 20th in science (DeSilver, 2015).

Table 2

Program for International Student Assessment 2012 Math Score Results

PISA 2012 Math Scores Average scores of 15-year-olds taking the 2012 Program for International Student Assessment			
Singapore	573	Russian Fed.	482
Hong Kong	561	Slovakia	482
Taiwan	560	**United States**	**481**
South Korea	554	Lithuania	479
Macao	538	Sweden	478
Japan	536	Hungary	477
Liechtenstein	535	Croatia	471
Switzerland	531	Israel	466
Netherlands	523	Greece	453
Estonia	521	Serbia	449
Finland	519	Turkey	448
Poland	518	Romania	445
Canada	518	Cyprus	440
Belgium	515	Bulgaria	439
Germany	514	U.A.E.	434
Vietnam	511	Kazakhstan	432
Austria	506	Thailand	427
Australia	504	Chile	423
Ireland	501	Malaysia	421
Slovenia	501	Mexico	413
New Zealand	500	Montenegro	410
Denmark	500	Uruguay	409
Czech Republic	499	Costa Rica	407
France	495	Albania	394
United Kingdom	494	Brazil	391
Norway	489	Colombia	376
Portugal	487	Qatar	376
Italy	485	Indonesia	375
Spain	484	Peru	368

Note. The 58 countries and their correlation scores on the math PISA test.

Another long-running standardized test, the National Assessment of Educational Progress (NAEP), found that United States students made substantial math gains since 1990. DeSilver (2015) notes that a report from the National Science Foundation shows that while eighth-grade scores "show a continuous upward trend, fourth-grade scores leveled off in recent years." Table 3 is reflective of the 2013 United States NAEP math score results.

Table 3

2013 United States NAEP Math Score Results

2013 United States NAEP Math Score Results – 8th Graders % at each achievement level of the National Assessment of Educational Progress									
Ranking	1992	1996	2000	2003	2005	2007	2009	2011	2013
Advanced	3	4	5	5	6	7	8	8	9
Proficient	18	20	21	23	24	25	26	26	27
Basic	37	38	38	39	39	39	39	39	38
Below Basic	42	39	37	32	31	29	27	27	26

2013 United States NAEP Math Score Results – 4th Graders % at each achievement level of the National Assessment of Educational Progress									
Ranking	1992	1996	2000	2003	2005	2007	2009	2011	2013
Advanced	2	2	3	4	5	6	6	7	8
Proficient	18	20	21	23	24	25	26	26	27
Basic	37	38	38	39	39	39	39	39	38
Below Basic	42	39	37	32	31	29	27	27	26

Source: National Center for Education Statistics: Pew Research Center
Note. NAEP score progression for the United States over the span of nine years.

The 2013 United States NAEP math score results rated 42% of fourth-graders and 36% of eighth-graders as “proficient” or “advanced” in math. While far fewer students now rate at the lowest performance level (17% of fourth-graders and 26% of eighth-graders, versus 50% and 48%, respectively, in 1990), improvement in the top levels has slowed considerably since 2007. What this shows, is while United States students scored in the upper third of all nations in fourth-grade math assessments, they tend to fall significantly behind in middle school years, and by the time they reach their final years of high school, they are significantly behind several countries, academically (Mitchell, 1993). Therefore, the focus of the education system has been to help educators work with students to prevent them from falling behind as they progress through their schooling.

Extensive research has been conducted on the use of strategies such as cooperative learning and project-based learning in mathematics instruction to help keep students from falling behind (Zakaria & Iksan, 2007). Many of the studies showed that the use of project-based learning techniques lead to positive attitudes toward a variety of subject areas, including mathematics, as well as an increase in academic achievement (Johnson, Johnson, & Smith, 2013; Topping, 2005; Walmsley & Muniz, 2003). Many students lack the strong educational foundation necessary to be a successful math student, thus have a difficult time as a student in connecting new mathematics knowledge with the lacking prior knowledge. Knowing that these weaker students integrate newer knowledge poorly, it is the job of the educator to design and develop methods in teaching that will assist in bridging this learning gap. In addition to a poor mathematical foundation, many students lack the overall academic confidence in themselves which, in turn, has an effect on their overall academic achievement. Over the years, educators have expressed concerns that students' thinking skills, motivational outlooks, and knowledge are insufficient to “lead fulfilling lives in a new global, information-rich, technology-oriented world” (Blumenfeld, Fishman, Krajcik, & Marx, 2000, pg. 149). In addition to these concerns, institutions of higher education are becoming increasingly troubled by failure remediation due to its impact on the current world (Perry, 2003). Therefore, these institutions are focusing their efforts into training educators how to face this dilemma once they get into the classroom. As previously stated, a part of educational success is for students to have the ability to transfer and apply their skills knowledge. Likewise, the education process is not limited to the four walls of a classroom or only within a school (Harris, Mishra, & Koehler, 2014). Research has shown that students who are actively and authentically engaged in learning, learn better (Stearns, Morgan, Capraro, & Capraro, 2012). Focus must be placed on how students can see the meaning behind what they are learning, through active engagement and self-direction.

Education has shifted into a new era of how instruction should be presented within the classroom. The delivery method for instruction has shifted from the teacher-centered approach to a more student-centered approach (Harris, et al., 2014). The student-centered approach involves students taking a more involved role in their own learning process, while the teacher acts as a facilitator of the learning within the classroom. Project-based learning is a learning method that uses a hands-on, active approach within a student-centered learning environment. It is widely used to replace the traditional teaching method in which the teacher, who is the center, strictly following the teaching plan (Koparan & Güven, 2014). Transition into a student-centered learning classroom means educators must nurture students' understanding of learning objectives by making sure that the classroom environment appeals to all aspects of the students: physical, emotional, and social (Kaufman et al., 2008). This type of classroom setting is designed to afford students the opportunity to construct their own knowledge. This is done to allow students to be prepared to face and solve real-life problems through asking questions, designing and conducting investigations, gathering, analyzing, and interpreting information, drawing conclusions, and reporting their findings (Sterns et al., 2012). When academic expectation never undertakes the task of having activities that require students to construct questions about things, it is less likely that the higher level thinking skills of analyzing, hypothesizing, predicting, and problem solving will be developed (Helm, 2004). Education that incorporates the students' personal interests and allows for social interaction with fellow students proposes positive alternatives in comparison to traditional teacher-centered instruction (Grant & Branch, 2005).

Research Questions

The specific research questions that were addressed through this study are as follows:

1. Does the use of project-based learning activities incorporated into a middle school mathematics classroom show a significant difference in the mathematics achievement scores for eighth-grade students?
2. Does the use of project-based learning activities incorporated into a middle school mathematics classroom show a significant difference in motivation for eighth-grade students?

Importance of the Study

Can students' project-based learning activities be the means to move their learning from a passive to a more active approach, and thus possibly increase academic achievement and motivation? Researchers state that a project-based learning approach involves a change in the delivery and implementation of instructional content within a classroom (Gulbahar & Tinmaz, 2006). Project-based learning places the teacher as more of a facilitator and mentor, while the student assumes responsibility for the learning. This sort of active, engaging learning environment, coupled with strong teacher involvement and support, has the potential to greatly improve student participation and engagement (Cook, 2010). The learning environment must also provide an aspect for the learning to transfer into applicable situations. The basic knowledge of transfer in education must be specific for the actual scenario or situation, which means teachers and career planners must communicate. This is so that the knowledge can be applied through performance-based situations that are relevant to the current expectations of today's world (Middleton & Baartman, 2013).

Project-based learning allows students the chance to discover the solution to a problem their own way, using their own ideas and points of view (Preuss, 2002). Incorporating their perspective on things allow students to feel a sense of personal challenge with the problems they are trying to solve, they go to great lengths to solve them, leading to different ways to inquire to obtain the desired result (Chin & Chia, 2004). When extended into a group setting, the knowledge base grows, thus the modes of inquiry increase.

In a group setting, the shared feeling of ownership of a problem and obtaining its solution gives group members the motivation for reaching their desired goals together

(Saleh, 2010). One valuable component of project-based learning and its use of group settings, is that in groups, students are engaged in tasks that are designed to be realistic, applicable to real life, and interesting to the students (Howard, 2002). This element promotes social learning as students work together to complete tasks using modern-day skills, knowledge, and technological advancements (Bell, 2010). When a group of students work together on a task, they usually perform better, as they are constantly collaborating ideas to get the best outcome for their task (Lou & MacGregor, 2004). Likewise, if students perceive a task at hand as being relevant to their lives, they are more apt to give a more valiant effort towards not only completing the task, but retaining what they learned into long-term memory as they know it can help them in the future (Howard, 2002). Working in groups not only promotes collaborative learning, but also allows the students to make connections with fellow students, building a classroom community of learners who all wish to obtain the same learning result (Chin & Chia, 2004). Students in a project-based learning environment engage in authentic problems, which may result in permanent knowledge (Gulbahar & Tinmaz, 2006). Jane David (2008) stated in her article on project-based learning, "worthwhile projects require challenging questions that can support collaboration, as well as methods of measuring the intended learning outcomes" (pg. 81). Desired outcomes seem to occur effortlessly within the students of the class. Outcomes such as increased student involvement, persistence, and motivation all work together to begin to define who the students are and how they view themselves as a learner (Chen & McGrath, 2004).

Project-based learning offers students possibilities to develop character qualities such as curiosity, creativity, and resourcefulness while developing team and interpersonal skills (Chin & Chia, 2004). It also leads to higher level thinking, questioning, hypothesizing, and predicting, not just factual recall (Helm, 2004). This type of learning also motivates students to learn emerging academic skills, and work to develop them to be academic strengths. Project work in the classroom stimulates students' cognitive development through investigation, analysis, and experiences (Clark, 2006).

This specific study is important for a variety of reasons. The results of this study provided a data-supported perspective on the use of project-based learning activities as a teaching method in mathematics, and how this method affects the academic achievement and motivation of middle school students toward the subject of mathematics. The project-based learning activities in this study were aligned with the national Common Core Readiness Standards (CCRS, 2015), Alabama State Department of Education (ALSDE) objectives, and the Mobile County Public School System (MCPSS) pacing guide so that the proper, grade-level appropriate target-skills were used. The use of project-based learning activities in the mathematics classroom could prove to be a constructive alternative for academic improvement in schools that are seeing a decline in academic achievement and motivation amongst their students.

This study investigated the influence of project-based learning activities on the academic achievement of eighth-grade students, specifically in the area of mathematics. The results from this study could be used to address the need for a change in the method of assessing mathematics skills for developing learners. Many times, the proverbial "wall" that students hit in math is when they take the skills learned and are required to apply them to performance-based scenarios. Project-based learning activities may give them practice in this area, causing them to think deeper into the relevance of the skills and applications, rather than just memorize a formula that has no depth of meaning.

This study is helpful to mathematics educators, as it provides an alternative perspective toward a mathematics classroom environment. Educators can review the data from this study and make a professional decision regarding the incorporation of similar project-based learning activities as a means of teaching and assessment within their classrooms. The educational implications this study provided could be valuable to mathematic teachers and coaches. The outcome of this study provided evidence as to whether or not project-based learning activities was a valuable teaching method for teachers who are looking for ways to actively engage and motivate their students. Johnson et al., (2013) showed in their research that low-performing students benefit from these cooperative learning methods, group work and peer interaction. This is due to the fact that these types of teaching methods help build social skills, confidence in personal abilities, and motivation in students by them being able to learn from others (Johnson et al., 2013). The results from this study could be important to administrators who are trying to use research based activities and strategies that could possibly influence standardized test scores. Globally, project-based learning can equalize the platform in which students learn. The results from this study can be vital to educators and the public alike, as there is a constant demand to find valid, research-based teaching methods that better prepare students, both academically and socially, for success as a member of society.

Definition of Key Terms

The following terms are defined to avoid misinterpretation.

Cognitive structure - The basic mental process of organizing existing information and new information to be learned. Cognitive structure provides a stable and organized framework to construct new knowledge. Cognitive structure is an indication of an individual's organization of concepts in memory and the relationships between them (Anderson, Randle, & Covotsos, 2001; Atabek-Yigit, 2015).

Cognitive theory - A theory which places the learner at the center of their learning and focuses on the construction of knowledge from within (Piaget, 1952).

Common Core Readiness Standards (CCRS) - A set of high-quality academic standards in mathematics and English language arts/literacy (ELA), which outline what a student should know and be able to do at the end of each grade. The standards were created to ensure that all students graduate from high school with the skills and knowledge necessary to succeed in college, career, and life, regardless of where they live (CCSSI, 2015).

Cooperative learning - An instructional method where groups of students work together on tasks within conditions that meet the following criteria: positive interdependence, individual accountability, face-to-face interaction, problem solving, appropriate use of collaborative skills, and self-assessment of team functioning (Deubel, 2003; Johnson et al., 2013).

Guided practice – Interactive instruction between the teacher and the students in the classroom, working on the objective skill at hand. After learning, students practice process by engaging in a similar task.

Independent practice - Student practice that correlates to the lesson taught which is completed without teacher guidance (Combs, 2007).

Intrinsic motivation - An individual's personal interest in a topic that is satisfied through pursuit of that topic. Intrinsic motivation embodies a student's desire for mastery, spontaneous curiosity, and inquiry (Unrau & Schlackman, 2006). Motivated Strategies for Learning Questionnaire - A modified Likert-scale questionnaire designed to assess motivation and focus of students. From this point on, this will be referred to as the MSLQ.

Project-based learning - An instructional method in which projects or tasks, often in the form of objective-based problems, serve as the context for building a knowledge base as well as critical thinking (Howard, 2002).

Self-efficacy - A set of beliefs concerning a person's ability to analyze and implement a course of action. This can affect how individuals handle adversity. When facing adversity or failure, a person with high self-efficacy is more likely to continue to give greater effort and persistent towards the end goal than a person who has low self-efficacy (Jackson, 2002).

Self-regulated learning - The process that students use to activate prior knowledge through their own thoughts, in order to accomplish their goal. Students who are self-regulated pace themselves and their learning process. They set goals, plan out strategies to accomplish those goals, and give effort throughout to see the task through to the end (Zimmerman, 2002).

Student-centered environment - An environment in which students are given a task to complete using a specific set of skills and knowledge on the content area. They must work as the instructor to gather and use the resources needed to be able to complete the task and evaluate their work (Pedersen & Williams, 2004).

Teacher-centered instruction - Instruction designed with the teacher as lead guide and deliverer of the instruction and classroom (Gonzales & Nelson, 2005).

Traditional instruction - Teacher-centered lessons in which information is transmitted through lecture, demonstration, and individualized skill practice (O'Connell, 1999).

Chapter Summary

The intention of this research study was to aid teachers in providing quality mathematics education to all students that is also relevant to the educational expectations of the 21^{st} century. As noted in the data from the PISA and NAEP testing results, mathematics proficiency in the United States is not up to national or international standards (DeSilver, 2015). Therefore, the focus of the educational system is now on determining why this is, and how it can be improved. Project-based learning is one possible strategy to incorporate into mathematics classes, as a method to improve on academic achievement and student motivation toward learning mathematics. Allowing students to use project-based learning activities as an instructional application method of mathematics skills is perceived to be a more genuine way of preparing learners for the performance-based scenarios they would face in life.

In today's career fields, students are expected to begin a job with the ability to observe, analyze, and process the problem at hand without much assistance. From there, they must apply their problem-solving skills to develop a solution for that problem, as an individual or as a member of a team, if the situation calls for it. The foundational concepts of project-based learning are to motivate students to encourage and help each other master skills presented by the teacher (Slavin, 2011). Students are driven by the desire to succeed, thus project-based learning is an ideal solution to that desire for educational success. This drive for success is also seen in students when working in teams. In project-based learning teams, or groups, students help their teammates observe, analyze, and problem-solve while encouraging each teammate to do his or her best in their contribution to the project. Therefore, each student is engaged and contributing while receiving support so that the team can succeed. This positive form of social interaction expresses to the students that learning is important, valuable, and fun. Although students study and work together in these teams, each student is still responsible for knowing the material through individual accountability of their part of the activity. Working in a setting where they have accountability partners within their teammates, students are motivated to apply themselves and hone skills by asking for help from others. In doing so, they are working toward success for themselves and their teammates. Individual accountability in effort and academics is the driving motivational factor for students to do a thorough job teaching each other, as the team succeeds when its individual members succeed.

Through this present study, all these factors were considered and designed into the lessons of instruction to ensure the project-based learning activities were used in the most optimal way to affect students' mathematics achievement and class motivation in the most productive way. This method of active learning puts students at the center of the learning experience and process. Through this study, the data on how the incorporation of project-based learning activities impacted the achievement and learning motivation of the students toward mathematics was analyzed. This research study provides significant information in the area of project-based learning being a valuable teaching method for teachers to use in all classrooms to improve students' academic achievement and motivation in mathematics

Chapter II - Review of Literature

Introduction

In the field of education, there has been an increased emphasis on creating classrooms that incorporate opportunities for students to become independent learners. This approach toward learning increases the accountability of the learners for their own learning and aims toward developing lifelong learning (Sungur & Tekkaya, 2006). Project-based learning is an approach for creating independent thinkers and learners (Bell, 2010). It changes the environment for learning from teacher-centered to student-centered, hence allowing the students to recognize their talents, hone their skills, and increase their opportunities of academic growth (Hertzog, 2005).

Project-based learning classrooms enable students to create meaning from their learning by realizing the importance of a specific subject matter, as well as how all subject matters relate to one another (Helle, Tynjala, & Olkinuora, 2006). Students' academic abilities increase under this type of classroom environment, as it is a student-driven, motivating approach to learning, which allows for a gain of valuable skills that will build a strong foundation for the students' future (Bell, 2010). Project-based learning activities in the classroom support social learning as students' practice becoming proficient in skills such as communication, cooperation, and teamwork (Bell, 2010). According to King (2002), when students are able to work on projects with their peers, they develop their ability to relate information at high levels and create systems in which new ideas are connected.

Furthermore, when students are actively involved in a knowledge-building situation, they benefit from instructional goals that extend beyond the learning goals set in the classroom (Howard, 2002). For example, Solomon (2003) suggested project-based learning addresses the important needs of a diverse population of the classroom by creating a learning environment that is impartial to students from different backgrounds. It allows the students to work with one another on an intellectual level, ruling out other social barriers that tend to exist within a school environment. Students learn to depend on, and develop consideration for others and their viewpoints, and feel comfortable enough with their peers to interact to accomplish a goal. Therefore, learning in this type of environment typically becomes more enjoyable and worthwhile to the students; it often leads to success in academics as well as the development of social skills (Gultekin, 2005).

Active Learning

Any parent can attest to the fact that as a child grows in age, so does that child's desire for independence in areas of life. Middle school students are a collective group of children who are working daily to find the balance between being directed and making decisions through life. Anytime children, or students in this case, are allowed to make their own choice about something, it becomes personal to them as it allows them to accept responsibility. When students are allowed to make decisions about their own learning, their desire to learn is likely to increase (Song & Grabowski, 2006). This increase in learning desire is what educators everywhere want for their students. Engaging students within the classroom allows for them to take a personal stake in the learning, through making choices about what they are involved in and how it will turn out. This hands-on engagement that allows for personal viewpoints and choices is called active learning.

Active learning recognizes individuals have to connect with the content and with others, communicate prior ideas, make connections between ideas, and create new knowledge from their experiences (Ueckert & Gess-Newsome, 2008). The optimal way to do this is to actively engage students within the learning environment and process. When the learning environment is activity-centered, and the students' experiences and differences are taken into consideration, they will experience success (Gultekin, 2005). A teaching method that is a product of active learning is project-based learning. This teaching method allows for students to work actively, individually or within a group, to construct new knowledge. Through project-based learning, active learning and knowledge seeking takes place to look into core skills in the classroom (Kucharski, Rust, & Ring, 2005).

Gultekin (2005) explained through his research that the learning environment is more effective when it is comprised of productive and creative activities that will grasp the students' attention, and desire to learn. The more creative the activities, the more engaged the students will be in the learning process, therefore there is more potential for academic success. When students work on projects in this type of active learning environment, they become better researchers, communicators, and managers of resources used to complete the task (Gultekin, 2005; Kucharski et al., 2005). The diversity of activities present in the project-based learning teaching method makes it possible for most students to have an opportunity to connect in learning that is successful for them (Kucharski et al., 2005).

In the research study of Mueller and Fleming (2001), 29 sixth- and seventh-grade students were the participants who worked over a span of 5 weeks within peer groups to see the effect of cooperative learning when working amongst their peers. The students were engaged in a project to design an amusement park ride for a class exhibition. Two classrooms were arranged to allow students to take part in small-group investigation for a period of time. Projects were outlined to provide chances for students to develop ranges of information and knowledge about the subject area, in this case, science (e.g., research reports, scale drawings, and models). Through these investigations, students were allowed the chances to make informal and formal presentations of their findings.

After the project, students' reflected on what they had learned. 54% of the students stated they felt they had improvements in their knowledge of science and how to apply it in a realistic way. Additionally, 35% of the students reported that their learning was directly related to the enjoyment they had through taking part in the project (Mueller & Fleming, 2001). The students also stated that they learned better when they were able to actually create something, as opposed to just using a book for learning. The results of the study showed that female students emerged as group leaders in all of the groups, and although problems did arise, all the groups found ways to cooperate to the extent of still completing their project requirements (Mueller & Fleming, 2001). The findings from this case study lend themselves to the current study in that they all show the academic achievement of students when completing a project they were actively involved in the process from start to finish. This study used active learning which allowed students to see the application of the skills they were learning, and the relevance of these skills outside the classroom, which this research study also meant to accomplish.

The relevance of active learning to this study is that motivated, engaged students who are getting hands-on experiences are more apt to want to continue learning. The right combination of techniques in application with the subject area and objective must be used in order to have the desired outcome of active and engaged students. The studies here show that active learning techniques used in a science classroom built up students' self-efficacy in some ways, and attitude toward chunked parts of the activity in others. The method and techniques discussed in the active learning studies were beneficial to the current study, as it was the foundation for the planning of the standards-based lessons to encourage positive student engagement and motivation toward the mathematics activities.

Student-Centered Learning

Sungur et al., (2006) suggested present-day education must provide students with a learning environment where the relevance and experiences of the world are brought to the learners. This allows the learners to become immersed in the learning process, imprinting a sense of ownership to the learning outcome as students incorporate the scientific processes of experimentation through personal learning choices. The constructivist approach to learning also talks of how the students should construct their own knowledge base through experiments and experience (Vygotsky, 1978). Traditionally, classrooms are teacher-led from start to finish, with little to no time for peer interaction allotted. This traditional classroom concept is being shifted to the side to make way for a newer constructivist approach known as student-centered learning. Student-centered learning allows students the opportunities needed to enhance critical thinking skills and helps mold their learning process by being active participants, focusing on meaningful, inquiry-based, authentic activities. (Garrett, 2008; Gulbahar &

Tinmaz, 2006).

Student-centered learning is the learning taking place in project-based learning activities as it allows the students to take the lead role in the learning environment. Student-centered learning is beneficial to the learning environment, as it is able to reach a large range of students with different learning abilities, because it creates possibilities for students to work toward a solution in their own distinct way (Kucharski et al., 2005). Helle et al., (2006) stated that student-centered environments pay careful attention to the knowledge, skills, attitudes, and beliefs that learners bring to the educational setting. The teacher would need to recognize the skills that the different learners bring into the setting and allow the students to work within ways to bring out the best in each learner. Student-centered environments allow opportunities for the participants to use their prior knowledge and experience in order to enhance their own skills and abilities as wells as those of the group (Helle et al., 2006). When working as a group, students are able to share their strengths to help improve individual skills, so that each student can walk away with a deeper understanding of what learning can do for them.

According to Helm (2004), students can gain self-confidence to accomplish goals when the focus of classroom activities is directed away from the team, and more toward the students. Students are less able to develop higher level thinking skills of analyzing, hypothesizing, predicting, and problem solving when the classroom setting is teacher-directed. A main reason for this is students are not given any time to think outside what is being directed at them. Humans, children especially, and naturally inquisitive. Learning environments that stifle the instinct to question things are not beneficial to students in their learning development. Student-centered approaches to learning focus on engaging material that challenges students, giving them opportunities to demonstrate their strengths and talents (Hertzog, 2005). Meaning, rather than teaching students about pop-art by showing some slides, allowing students to research the topic and create their own art piece will produce more meaningful outcomes. This then incorporates student-driven research, personal creative aspects, and an end product that the students have produced on their own, and are likely to be proud of as a result. Solomon (2003) suggested such an approach is designed to engage and empower students with the responsibility of their own education and train them to take complex issues and problems and break them down into specific action steps.

Project-based learning activities are student-centered, offering generally risk-free environments where students are able to learn from their mistakes and give honest answers in an environment that is nonthreatening (Solomon, 2003). Students can often be afraid to be honest about a situation, especially if they do not understand a concept. Outlying factors (unforgiving teachers, fear of failure or ridicule) have an impact on students, creating individuals who would rather fail in silence than lose face in front of peers and their teacher. Allowing the students to each drive their own learning, it places this fear toward learning out of mind, as students realize they are all starting from the same knowledge base point. Chin and Chia (2004) suggested when working together, students should always have the freedom to question any of the groups' decisions, which may drive their inquiry and motivate them to hypothesize, predict, and reflect on their own ideas. Through this process, teachers will gain an understanding for how their students think and learn as individuals and in groups providing valuable patterns in learning that can aid a teacher in designing and implementing techniques to increase student success in the classroom (Hertzog, 2005).

In the research study of Chin and Chia (2004), authentic investigation done by students while working on projects was evaluated, and how it affected students' self-evaluation of how well they learned the objective skills. The participants of their research study were 38 females who were separated into four to five groups within a ninth-grade biology class. Each group worked for 2 weeks on projects that they were able to pick the topics based on the theme of the intended objective. The job of each student was to bring ideas to the group to help create the topic that they chose in the end. The groups then designed their own project tasks based on the objective. The teachers in this study created a forum page on the Internet for the students to contact professionals or to do any other research for their projects. During the study, the groups recorded their information in a learning log, where they also wrote out their plan for their next investigation steps (Chin & Chia, 2004).

Students’ feedback on their project experiences was recorded in two questionnaires. On the portions that reflected knowledge application skills, 89.7% of the students stated they were able to search for information from various sources. 74.4% of the students in this study responded that they felt what they learned in their project was applicable to their lives. Most of the students (76.9%) agreed they were inspired to do the project because of some related daily life experiences, and 89.7% indicated the information they had learned was going to be helpful to them in other related subject areas (Chin & Chia, 2004). This study suggested that when realizing that what they learned was relevant to real life, the students had the motivational drive to finish out the projects.

Gultekin (2005) conducted a study that examined the effects of student-centered learning on the learning outcomes of fifth-grade social studies students. Two research questions guided this study: first, is there a difference between the academic achievements of experimental groups of students and control group students? Second, what are the opinions of the students and teachers regarding the student-centered learning approach? This study consisted of 20 students in the experimental group and 20 students in the control group. The two groups were separated based on their grades in the social studies course, personal characteristics, and the scores from the achievement test. The experimental process lasted for 3 weeks, and it consisted of different stages that included identifying the objectives; identifying and defining the task to perform or the problem; gathering, organizing, and reporting the information; and presenting the results and the conclusion (Gultekin, 2005).

According to the results of the study, the student-centered learning approach that was applied to the experimental group had a positive effect on the academic success of the students in the social studies course. The qualitative data showed the students found this approach to teaching and learning tactic was motivating and enjoyable. The students also reported that by doing these projects, they had to work harder to do the research part of things, which was beneficial to them so they could contribute to their group. The most evident result of this study was that the student-centered learning approach improved academic success of the students. The student-centered learning approach also helped to develop essential skills that the students are able to implement in all subject areas. This learning approach enhanced the students' study habits by making the learning process enjoyable, entertaining, meaningful, and permanent. Student-centered learning was reported by the students as to have helped them become aware of their strengths and become more willing to delegate different tasks to fellow students who were better suited to get a specific part of the project done for the benefit of the entire group (Gultekin, 2005). In comparison to the current study, similar student-centered learning techniques developed and built skills within each student so they can use these skills to further their learning beyond a mathematics classroom. It is important for students to realize that they can rely on others to help build up areas of need, and allow for a loss of control in some ways, by trusting in their peers to pull their weight of the work in a group project. Student-centered learning takes a single objective and uses it to teach learning, social, and life skills such as investigating, analyzing, communication, and application.

Transfer of Learning

Transfer of learning has been a research topic for most of the 20^{th} and 21^{st} centuries. Thorndike and Woodworth conducted a study in 1901 that dealt with the examination of how learning that takes place in one environment or setting affects the same learning within a different environment. This study was the early onset of looking at how the process of learning can and does transfer into other settings for potential use and application. This then presents the question: What is successful transfer of learning? Successful transfer of learning is best described as when something that is learned in one environment can be used to promote the same learning within another environment (Thorndike & Woodworth, 1901). Thorndike and Woodworth were some of the first to examine commonalities amongst learning and the learning processes. In the 20^{th} century, researchers such as Bransford and Schwarz (1999) studied similar commonalities like the belief that learning difficult subjects, such as a foreign language, increased people’s learning skills. These research studies revealed that while people may test well on certain skills and objectives, they may not be able to take that knowledge and appropriately apply them into real life situations where those skills are necessary amongst other skills.

Perkins and Salomon (2012) make the point in their research that without motivation, there is no successful transfer of learning. Likewise, Bransford and Schwarz (1999) discuss that people must be willing to collaborate and hear others experiences and ideas on active learning transfer, to be aware of any pitfalls that may occur with actually applying the knowledge in a real world setting. Bransford and Schwarz stated that being able to recognize that learning transfer happens naturally in many cases, because the ability to transfer learning is always there. Perkins and Salomon (2012) enforced the concept that understanding the role of motivation as the key component that connects the transfer of learning together from one environment to the other, will allow one to predict whether successful transfer of learning will take place.

Stevenson, Boakes, Prescott (1998) was a predecessor to Perkins and Salomon (2012) in agreeing that motivation is a key component of successful transfer and undertook studies which examined the features that contribute towards successful learning transfer. They examined learning transfer where the skills being taught and therefore learned by the students were similar to the transfer requirements. They also reviewed if there were any significant differences between the learning and transfer requirements, where those differences were if so, and why there were differences. In addition, they found students' sense of personal ownership of learning process here was a key motivator of them learning the materials at hand, to ensure the most successful transfer of learning possible. It is important for students to be able to design and develop their own learning processes, through which they will acquire knowledge, translate it into action, and better understand the outcomes of these actions (Iyengar, Sweeney, & Montealegre, 2015).

Transfer of learning is important to the overall learning process. It is the taking of knowledge and putting it into action by way of application or demonstration. One of the most important roles transfer plays in the learning style of project-based learning is transfer increases the students' abilities to take what they learn in class into the community where they live. Meaningful experiences through projects enable the students to use higher order thinking skills that will increase their academic as well as their interpersonal skills (Iyengar et al., 2015). Classrooms should be designed so students can work in groups effectively (Sungur et al., 2006), while addressing differences and a variety of learning styles and abilities of all the students (Solomon, 2003).

For a subject to improve students' learning experience, Middleton and Baartman (2013) suggested the transfer of learning must be present. This concept allows for learning to apply to other subjects as well as out-of-school circumstances. Students should be given opportunities to ask and answer thought-provoking questions, and to think deeply about a variety of materials so they can create connections between prior and new knowledge (Middleton & Baartman, 2013). When students learn what they may accomplish is of value beyond the classroom, higher order thinking skills are developed and honed (Solomon, 2003). Learning is also made permanent because students are developing a variety of skills to improve their learning in other areas that are important to them (Gultekin, 2005). When students are part of a knowledge-building community, they are actively involved in acquiring information, and their learning goals extend outside the classroom (Middleton & Baartman, 2013).

When students believed an activity is important in their daily lives, they were more likely to put in the time and effort to finish it (Middleton & Baartman, 2013). Through project-based learning, the students demonstrated this knowledge by high-level thinking and problem solving, which results in a focused learning experience (Middleton & Baartman, 2013). Therefore, these meaningful academic outcomes increased in-depth understanding of issues and concepts, retention of learned skills, and the ability to apply learned knowledge to other areas of the students' academic and social life (Solomon, 2003).

The ability to showcase the transfer of learning skills into performance-based scenarios through project-based learning increases the students' characteristics of curiosity, focus, problem-solving skills, creativity, and self-motivation, which leads to lifelong learning (Hertzog, 2005). Through working with their peers on group activities, students will be better prepared for their next level of education, as well as their lives as adults and involvement in the community (De Lisi, 2012). Many times, through active activities, students are drawn into their social environment, and can see the relationship between what they need to learn and how it affects them personally (Gultekin, 2005). Therefore, the connection between existing knowledge and new knowledge is strengthened and the learned task is seen as important outside the classroom (Lou & MacGregor, 2004).

Krebs (2003) reviewed a case study which examined students’ learning in a standard-based curriculum setting. The purpose of the study was to look at students' abilities to generalize data and transfer the information into projects within a mathematics classroom. Ten middle-school students were randomly chosen to participate in the study. Four project topics were given out, and each was developed to include a variety of mathematical content. The tasks were similar in nature, as they each asked students to study, make predictions for future values, and then generalize what they discovered (Krebs, 2003).

In two of the tasks, students explored two different patterns: one linear and one quadratic. In the other two tasks, students investigated one exponential pattern and one quadratic pattern. All student were divided into pairs, and participated in exploring the problems presented through the projects. The major findings from the study claim that middle-to high-achieving students who participated in this study demonstrated achievement in the five strands of mathematical proficiency. This means these students were able to take the learned objectives and transfer knowledge through application within the project, in order to complete the task.

Transfer of learning played a role in the current study, because this study looked for ways to connect the students to the learning beyond the classroom. Students needed to see the relevance of the tasks they were completing, so they could understand the concept as it applied to the subject at hand as well as outside of school. Transfer of learning allows for just such a connection, because it takes concepts beyond the four walls of a classroom and shows the practicality of the skill in life. For the current study, the skills in question were math related, so students needed to be able to transfer basic and complex math skills into performance-based situations they may face outside of school. Implementing project-based learning activities and techniques, this study showed how a strong educational foundation showcasing relevance and application was essential for successful students.

Cooperative Learning

In every classroom, goals are set daily with activities planned around those goals to help accomplish learning for the learners (Johnson et al., 2013). A learning goal is a desired future state of demonstrating competence or mastery in the subject area being studied (Johnson & Johnson, 1999). The setting of goals, or goal structure, specifies the ways in which students will collaborate as well as work individually, during the class period in order to try and meet those desired outcomes. Goals may be set daily, weekly, and monthly, and may reach out to incorporate both group and individualistic efforts to get a task done. It would be ideal for all students within a class to work together, interact and incorporate joint ideas, and have fun while learning. However, there must be time for individual learning, too, to ensure that one can act alone in demonstrating knowledge as this may be applicable to the nature of learning at times. Therefore, it is then up to the teacher to decide when and where what type of learning and goal structure should be implemented so that every student gets an optimal opportunity to learn. The most important goal structure, and the one that should be used the majority of the time in learning situations, is cooperation.

Cooperation is coming and working together to accomplish a shared goal, hoping for the same desired outcome amongst group members (Johnson & Johnson, 1999; Johnson et al., 2013). Ideally, within cooperative situations, individuals want outcomes that are not only beneficial to themselves, but to every group member involved, thus the accountability is placed upon all members to do their best for the sake of the group.

Cooperative learning is using small groups of students, and having them work together to collaborate ideas, to obtain a learning outcome that shows this maximization of their own learning strengths towards the task (Johnson et al., 2013). While there are limitations on when and where competitive and individualistic learning may be used appropriately within a classroom or on a certain objective topic, any learning objective and subsequently related task in any subject area with any curriculum may be structured cooperatively, if an instructor takes proper care in seeing that it is done correctly for optimal learning to take place.

Research has shown that the use of cooperative learning has been linked to an increase in student motivation and achievement (Johnson et al., 2013; Johnson, Johnson, & Stanne, 2000; Topping, 2005; Walmsley & Muniz, 2003). Educators are advocating the use of cooperative learning within schools, due to the potential this method has to create an increase in student achievement through the development of social skills in student interactions (Siegel, 2005). The current world of education in today's age is one where a strong emphasis is being placed upon testing and test scores. In knowing this factor, teachers must stay up to date with the generation, by engrossing themselves in new methods of teaching to engage the students. The way students interact with each other is a factor that is often times ignored in an education world that wills them to remain quiet and work independently. This removal of interaction, however, is creating a weakness in student learning that should not be, and for this reason, encouraging interaction between students by the use of cooperative learning appears to be the leading approach to instruction in the classroom (Barratt, Colby & Dyson, 2016). Teachers should put cooperative learning strategies into their plans so students get the opportunity to work together in order to complete an assigned task (Graham & Perin, 2007). Requiring students to become actively engaged in the learning process will encourage in-depth learning (Ravenscroft, Buckless, & Hassall, 1999).

Cooperative learning, dating back to Dewey, is widely used in the educational community today (Lambert et al., 2002). Dewey promoted the act of grouping students in order to explore and solve problems (Ellis & Whalen, 1990). Dewey saw learning as a mapped out journey that is developed by the social construction of knowledge. When looking at the different models of cooperative learning, Dewey's approach to instruction is apparent; the models show students working together to understand knowledge by sharing their combined and individual experiences (Lambert et al., 2002). Countless research studies have shown that students who participated in cooperative learning activities have exhibited higher academic achievement, higher self-esteem, and better social skills (Johnson at al., 2013; Slavin, 2011). Johnson et al. (2013) confirm over 700 studies have been conducted on the use of cooperative learning since 1898.

Theoretical Perspectives of Cooperative Learning

Cooperative learning is structured around four theoretical perspectives, the first of which is the social interdependence theory. This theory directs educators in understanding how group structure can enrich the effectiveness of student learning (Deutsch, 1949; Lewin, 1935). This theory of learning represents the idea that a group, and how its members work together, influences the outcome of any activity they are working on together. Lewin (1935) acknowledged the fact that children might come to a group with differing viewpoints, but if they have a shared goal, they are likely to work together to accomplish it.

Johnson et al. (2013) expressed that when students are part of a group, they work to accomplish a task in such a way that is beneficial to both themselves and their group. All group members recognize that they must each bring something into the group, in order to get the task accomplished. This theory is evident in cooperative learning activities as team members rely on each other and work together to accomplish a goal.

The second theoretical perspective that cooperative learning is based upon is Piaget's cognitive theory. This theory is constructivist based, and places the learner at the center of their learning, and focusing on the construction of knowledge from within (Piaget & Inhelder, 1969). The basis of Piaget's claim is that learning is guided by intrinsic motivators, so the more self-motivated students are, the more they will achieve. Piaget felt that children's abilities to organize behavior patterns develop more quickly when they interact with each other than when they interact with adults. Eccles (2002) supports these claims when he claimed that personal interest in the assigned job task results in motivation from within. Piaget and Inhelder (1969) stated that cooperative learning is more beneficial for stimulating the student learners than formal learning instruction. Formal instruction lacks the brain stimulus that is associated with peer-mediated instruction (Piaget, 1952).

The third theoretical perspective that cooperative learning can be linked to is the constructivist learning perspective. This perspective dates back to Vygotsky (1978), who believed that children should play an active part in their own learning. This encourages the concept of role-reversal within the classroom. In role-reversal, the roles of the teacher and the student are reversed, placing the teacher in the role of knowledge facilitator rather than provider. The student is now in the role of being the constructor of knowledge. Vygotsky (1978) also stressed that social interaction plays a major role in cognitive development. He emphasized that interaction with others is essential to the construction of knowledge. Baloche and Piatt (1993) indicated that individuals often look to others for help when they cannot solve a problem on their own, therefore in a group setting, group members can often learn a great deal more from the educational diversity of each member. Obtaining the perspective of others often helps individuals see things from a different perspective, and many times new knowledge is constructed due to this. By sharing knowledge, students can benefit from distributed knowledge where their strengths complement each other and increase the knowledge base of each group member (Coke, 1996).

The final theory associated with cooperative learning is the motivational perspective. This theory primarily focuses on the reward or goal setting in such group settings (Slavin, 2011). The use of group goals and rewards boosts the achievement outcomes of cooperative learning when the group rewards are based on the individual learning of all group members. To ensure their success, all team members must work together, encourage each other, and learn the most that they can to receive the group result score they want (Slavin, 2011).

These four theoretical perspectives complement each other and provide groups of students with ample opportunities and motivation to construct new knowledge. Many supporters of Piaget agree that the interaction between students on learning tasks results in a boost in student achievement (Slavin, 2011). These same supporters believe that learning will occur when student interactions lead to helping explain new concepts, which result in a better understanding of the concepts at hand by the students.

Interdependence in Cooperative Learning

Cooperative learning aspires to shift the focus of teaching from lecturing to passive students to instruction through coordinating students' interactions with each other. In cooperative learning, instruction focuses on coordinating, stimulating, and encouraging interactions among students, with students anticipating to learn from their own activities and interaction with their peers (Shimazoe & Aldrich, 2010). Several definitions of cooperative learning exist in the educational community. Olsen and Kagan (1992) defined it as the following:

> A group learning activity organized so that learning is dependent on the socially structured exchange of information between learners in groups and in which each learner is held accountable for his or her own learning and is motivated to increase the learning of others (p. 8).

Johnson et al. (2013) defined cooperative learning as "is the instructional use of small groups so that student's work together to maximize their own and each other's learning" (pg. 3). The goal of a good cooperative learning group is that there will be collaboration amongst group members rather than individuals working alone. There are two main parts to cooperative learning: positive interdependence among a group of students, as well as individual accountability for each team member's own learning and the learning of other group members (Dahley, 1994). Positive interdependence is seen through the dependence each group member has on one another, to help accomplish a shared goal. One team member does not carry the load for all members of the team, so all team members must work as a unit, or the desired objective goal will never be reached (Shimazoe & Aldrich, 2010). Individual accountability helps to ensure team members take the responsibility for their own learning seriously, as the group depends upon it. Most cooperative learning groups are between four to six members, and are diverse in nature, in ways such as gender, ability, and so on (Topping, 2005). Diverse grouping is encouraged because of the belief that working with classmates of differing ability levels results in knowledge shared and gained by all members of the group.

Knowledge of the two key cooperative learning parts is not all that a teacher must have in order to successfully incorporate cooperative learning into their classroom. According to Johnson et al. (2013) and Vaughan (2002), there are five basic building blocks of cooperative learning that should be present in order for cooperative learning within a classroom to be successful for learning. They are: positive interdependence, face-to-face interaction, individual and group accountability, use of interpersonal and small group skills, and regular group processing of group functioning to heighten effectiveness. Face-to-face interaction encourages equal participation from all group members to work together to reach their goal. Positive interdependence is the concept that as individuals progress, the group will progress. Everyone in the group has to participate and contribute to help the team accomplish the task. Individual accountability could be a spot questioning one another on parts, or even a quiz to show depth of understanding on the skills. Group skills are the actions that take place within the group, such as how students take turns, speak to each other, and listen to each other. Regular group processing occurs when students take the time to reflect on the good and bad points of the lesson, and how they can learn from these points to push towards a successful end goal.

Elements in Cooperative Learning

Kagan (1994) identified four basic features of cooperative learning which include: positive interdependence, individual accountability, equal participation, and simultaneous interaction. Kagan's first two features, positive interdependence and individual accountability, are identical to those previously mentioned by Johnson et al., (2013) and Vaughan (2002). The third, equal participation, is similar to Johnson, Johnson and Holubec's face-to-face interaction, and the fourth feature, simultaneous interaction, suggests that all students are working together as a unit at the same time. Teachers do not have to use all four features each time they incorporate cooperative learning into the classrooms, as the features are interdependent from each other. Since they are interdependent, this allows teachers to pick and choose which features compliment the objective task being performed. The teacher should also consider the needs and abilities of the students and the assignment, to help best choose which features to implement into the cooperative learning.

Barratt et al. (2016) expressed in their article, that if none of these four features are included into cooperative learning groups, students will have more difficulty completing their activities. Research showed the use of cooperative learning strategies, which included some of the basic features, improved the achievement of students and resulted in positive interpersonal relationships between group members (Slavin, 2011).

Cooperative learning is not simply a learning technique or activity, it is a method of teaching which uses a wide variety of teaching techniques (Slavin, 2011). As previously stated, when teachers incorporate cooperative learning groups into their classrooms, they are giving up their role of being in control of the instruction, and allowing students to take control of this role. They use common teaching techniques such as lectures, whole-class demonstrations, worksheets, and role playing to present information, and the students will take over the application of the knowledge from that point (Slavin, 2011).

According to Muir (2006), cooperative learning is one of the best researched of all teaching strategies, having research conducted over many academic subjects, ethnicities, and achievement levels. Research on cooperative learning has produced both positive and negative effects resulting from this strategy. This relates to the current study because cooperative learning is a focal component of project-based learning. The groups must be able to work together, as well as the students' work individually, to accomplish a goal. In order to implement cooperative learning into a group, the structure of the concept of cooperative learning must be understood so it can be implemented in such a way as to obtain the desired outcome.

Ellison, Boykin, Tyler, and Dillihunt (2005) conducted a study which focused on individual learning preferences of students in elementary school. The sample population for the study was 138 fifth- and sixth- grade students. The school was within a low-income community, and the students were administered the Social Interdependence Scale which measured dispositional preferences. Results of the study indicated that in general, the students preferred cooperative learning over any other learning preferences.

Tan, Sharan, and Lee (2007) conducted a study to examine the effects of a cooperative learning strategy known as Group Investigation. This study looked at the use of this strategy in comparison to traditional whole-group instruction on the academic achievement and motivation to learn for a group of students. The sample population for this study included seven eighth-grade classes in Singapore. The results of this study found that neither method was more effective in promoting academic achievement, however, Group Investigation positively affected the high achievers' motivation to learn.

Gungor and Acikgoz (2006) researched the effects of another cooperative learning strategy, Learning Together, on primary school students' reading comprehension strategy use and overall attitudes toward reading. The authors utilized a pretest/posttest experimental design in their study, and a *t*-test was used to analyze the data. Results from the study revealed that the strategy of Learning Together was more effective than traditional methods on reading comprehension strategy use. The cooperative learning group used reading comprehension strategies more often than their traditional counterparts. The results also revealed cooperative learning made a significant difference on student attitudes toward reading.

Bilgin (2006) conducted a study using eighth-grade students that examined the effects of hands-on activities, incorporating a cooperative learning approach, on science process skills and attitudes toward science. The sample populations for this study consisted of 55 students from two eighth-grade classes, and both classes had the same teacher as their instructor. This study used an experimental pretest/posttest control group study design, with the control group taught via teacher demonstrations, and the experimental group taught using hands-on activities along with a cooperative learning approach. The results of the study revealed the cooperative learning group performed better on the posttests than the control group.

Siegel (2005), using qualitative methods, examined an eighth-grade teacher's personal definition of cooperative learning, and its use in his classroom based upon his definition. Data were collected from interviews and classroom observations. Results from this study revealed the teacher adapted the research-based model of cooperative learning for use in the classroom. All these supported the current study because they provided evidence of the benefits of using the cooperative learning instructional method of learning. The results also displayed in these studies that the students all responded positively to this style of classroom environment in comparison to traditional teacher-centered classroom styles.

Researchers have suggested students can benefit from interactions in a working group or team because their peers can offer them explanations in terms that can be easily understood and focus on the important features of the problem (Filippatou & Kaldi, 2010). Offering students many choices to explore and experience what is to be learned also allows them opportunities to develop a depth of knowledge to continue the learning process (Catapano, 2005). In classroom environments where students are encouraged to learn by doing, their critical thinking skills are enhanced, shaping their learning process toward higher-level thinking (Gulbahar & Tinmaz, 2006). In other words, where and how students learn should be inviting, encouraging, and allow for social activity where students work together often while sharing ideas and providing feedback. This type of learning environment provides the security students need to be academically motivated to succeed (Brown, 2003).

Through cooperative learning, students collaborate with their peers, and enhance critical thinking, problem solving, and decision making skills (Hoffman, 2002; King, 2002). Gonzales and Nelson (2005) stated that because “students have an opportunity to get into the trenches and confront the complex, messy aspects of real-world projects, they have an opportunity to obtain a more sophisticated understanding of the subject matter, as well as better technical and collaborative skills" (pg. 15). As students face numerous poorly-structured problems they have to work through, their problem solving and critical thinking skills are significantly better than students who have learned in a traditional setting.

Preuss (2002) and Gillies and Boyle (2005) agreed that when project-based activities through cooperative learning are incorporated with students' learning situations, their abilities to work with others are increased and learning is facilitated. This type of learning situation also provides problem-solving opportunities that incorporate real-world problems with the everyday class activities, thus enhancing the students' problem-solving skills (Lou & MacGregor, 2004).

Cooperative learning provides a setting where students can hold each other responsible for certain standards and behaviors that can help improve knowledge sharing within the group (Wentzel & Watkins, 2002). Cooperative learning has the ability to offer students a sense of belonging, which could motivate positive interaction in social and academic activities in the classroom (Wentzel & Watkins, 2002). When students work in cooperative groups, both the students with background knowledge in the problem-solving situation and those with little knowledge about the task can experience fairness and a sense of sharing with their peers (Hoffman, 2002).

According to Shimazoe and Aldrich (2010), cooperative learning to solve problems maintains effective development through growth in feelings and emotional areas because students can see how their knowledge actually helps their classmates. This type of setting also supports diverse grouping that can lead to a mixture of cognitive abilities that increase students' abilities to be successful in accomplishing their task. Cooperative learning with peers strengthens the classroom as a community due to the students' increased sense of ownership (Hertzog, 2005). Cooperative learning provides opportunities for all students to become leaders, thus enhancing the dynamics of the groups as well as the classroom (Harris et al., 2014). This type of learning increases respect and cooperation skills through interactions with other students which, usually leads to a successful team experience. Also, when collaborations between groups are present, a sense of community is present within the classroom. Therefore, this collaboration creates activities that are focused more on the groups' needs and the learning goals (Lou & MacGregor, 2004). Furthermore, when students provide feedback across groups, critical thinking and self-regulating skills are enhanced. As a result, students who are supported by their peers tend to be more motivated to participate in school-related activities (Wentzel & Watkins, 2002).

According to Harris et al. (2014), cooperative learning creates opportunities for students to improve academic skills, such as listening and communicating, and subject matter success by increasing deeper levels of understanding through discussion. The students' abilities to think through the steps in solving a problem make it possible for them to recognize areas in which they may be deficient (Helle et al., 2006), and they are able to help the group create a project that will enhance each student's academic success (Lou & MacGregor, 2004). Also, through building on their own knowledge base and collaboration with their peers, the students are actually enhancing their own skills and abilities instead of just memorizing materials they might think to be unimportant

(Gultekin, 2005).

Cooperative learning requires students to ask and answer thought-provoking questions about the task, to enhance their abilities to think deeply, and to use prior knowledge in order to solve new problems (King, 2002). Problem-solving skills maintain cognitive development through opportunities where students are allowed to question and explain different tasks, which in turn enhances thinking skills. Cooperative learning involves opportunities for students to be in group settings with meaningful tasks to accomplish, which enhances positive academic achievement (Gillies & Boyle, 2005). Students develop their interest, creativity, and interpersonal skills as they work together in order to accomplish a particular goal (Shimazoe & Aldrich, 2010). A cooperative learning environment offers a risk-free setting where learning is enhanced and where feedback and advice from peers is confined to the group, which can increase the motivation of reluctant students (Gillies & Boyle, 2005; Solomon, 2003). In addition, students are able to communicate their prior knowledge and skills with the group, thus helping to accomplish the common goals that are set (Lou & MacGregor, 2004).

Nur Azmin stated in his 2016 article on jigsaw-based cooperative learning that “to be effective, cooperative learning must be well-planned and structured with suitable learning materials and guidelines given to all participants” (pg. 92). As a result, cooperative learning provides chances for students to look at other students' work and give feedback that may develop both learners' understanding and achievement of the goals (Lou & MacGregor, 2004).

In combination with cooperative learning, project-based learning activities are essential for the success of students with varying knowledge and ability levels to be able to work together with other students, to join their knowledge and ability bases and accomplish a common goal (Lou & MacGregor, 2004). Student-led activities improve academic, listening, and communication skills along with enhancing the opportunities for students to manage their exchanges with their classmates in order to work effectively and have a successful learning experience from beginning to end (Azmin, 2016).

There are many benefits students and teachers acquire from the use of cooperative learning groups in the classroom. Studies have shown that working collaboratively with each other results in students learning more efficiently, and retaining more of what they have been taught (Muir, 2006). Additionally, students indicate they enjoy peer collaboration that leads to more positive attitudes toward learning experiences (Bilgin, 2006; Muir, 2006). Teachers enjoy the benefit of students engaging in positive behaviors when they use these cooperative learning strategies in the classroom. It has been found when teachers establish cooperative learning in their classrooms, they engage in more mediated-learning behaviors and direct fewer disciplinary remarks to their students than teacher who establish small-group work only (Gillies, 2002). These facilitated-learning behaviors and fewer disciplinary issues are factors the current study lends to, to provide evidence that project-based learning activities can successfully assist with multiple areas of concern within a mathematics classroom.

The use of varied grouping in cooperative learning proves to be beneficial. Research shows students of all ability levels benefit from the use of cooperative learning strategies (Azmin, 2016). For the majority of students, studies show equal benefits for students who are high, average, and low achievers. According to Slavin (2011), research in cognitive psychology indicates if information is to be retained in memory and related to prior knowledge, the learner must engage in cognitive restriction or explanation of the material. One of the most efficient means of explanation is explaining the information to someone else, and through explanation, the entire cooperative group benefits from the interaction and understanding that takes place during the lesson.

In addition to benefiting students in regular education classes, cooperative learning has also been shown to benefit students in special education. Janney and Snell (2013) recommend cooperative learning as a helpful strategy for students within an inclusive education. Slavin (2011) supports this by indicating cooperative learning can have positive effects on learning for students of all ability levels including those with mild disabilities. The positives for these students have been found in both the cognitive and affective domains of schooling (Shaaban & Ghaith, 2005). The use of cooperative learning strategies increases student attitudes toward learning when compared to individual learning strategies (Bilgin, 2006; Weiss, 2006). A factor may be students enjoy the social interaction and conversational aspect of cooperative learning. This interaction is also believed to result in students using more learning strategies (Gungor & Acikgoz, 2006). While involved in cooperative learning tasks, students see each other reading, questioning, explaining, criticizing, and thinking aloud. These observations and learning tasks, activate students' minds. The result is students who are involved in more than simply reading and answering questions.

In addition to activating students' minds, students' communication skills are improved (Topping, 2005). During the school years, these skills are not as important as achievement gains, but they will benefit students when they enter the career field of their choice. Being able to work with others is a very desirable character trait when trying to get a job, and the overall goal in cooperative learning is that students must hold an individual as well as a group responsible for task management and goal accomplishment. In the current study, these two concepts brought about new ways to formulate thinking on how mathematics should be taught, in order to reach the goal of accomplishment as it is defined by the school system. By using project-based learning activities that incorporate cooperative learning, this study has shown that this instructional teaching method had a positive impact on reaching mathematical accomplishment for middle school students.

Project-Based Learning

Success in school depends on the extent to which students engage and adapt in the classroom while learning a task (Patrick et al., 2007). In today's knowledge-based society, we need students to be prepared to enter into the workforce with the ability to learn constantly, think resourcefully, and apply innovations promptly (Liu, Wang, Tan, Ee, & Koh, 2009). In order for students to be prepared, the educational setting must provide opportunities for students to understand the importance of transferring their learned skills to situations beyond the classroom (Eskrootchi & Oskrochi, 2010). Such learning environments involve both the improvement in the knowledge of the subject matter and the development of skills such as task management and group collaboration (Helle et al., 2006). Project-based learning has extreme potential to aid in producing prepared students by implementing relevant and rigorous learning in order to meet educational needs (Harada, Kirio, & Yamamoto, 2008). Project-based learning is defined as a learning approach focused on the concept that students should work on real-life issues/problems, individually or in small groups, to produce tangible, relevant outcomes (Gultekin, 2005). This method of active learning is necessary due to the strong demand from the surrounding society that students should come out of school with the ability to face the challenges set before them by society and be successful (Cheng et al., 2008). In short, project-based learning is an approach capable of ensuring meaningful learning (Gultekin, 2005).

The primary goal of project-based learning is to enhance students' ability to apply knowledge, to problem-solve, and to self-direct their learning of skills through cooperation and collaboration with peers (Savery, 2015). According to Howard (2002), a goal of the project-based learning approach is to create a learning environment that permits constant exploration by students and teacher, and enables students to understand the kinds of problem that professionals encounter. An additional goal of project-based learning is to help students achieve competence in identifying and analyzing relevant information for solving problems and constructing new knowledge (Chin & Chia, 2004). This type of learning experience engages students through hands-on learning and allows for a variety of learning approaches that address students' individual differences in learning (Solomon, 2003). Project-based learning is also student-centered, requiring students to self-direct their learning so that they may see for themselves what they do and do not understand about a situation and develop methods to bridge this gap (Savery, 2015).

Developing students' capabilities to cooperate, communicate, and make decisions is a critical task (Hou, Chang, & Sung, 2007). Project-based learning is inherently valuable because it connects these critical skills to learning that is real. It involves skills such as collaboration and reflection, and it promotes social learning as students practice and become proficient in the skills of communication, negotiation, and relationship building (Bell, 2010; Karaman & Celik, 2008). In order for project-based learning to produce optimal results, the environment of its use should emphasize that knowledge to be obtained must be constructed through social interactions between students and shared outcomes are produced over a designated period of time (Cheng et al., 2008). Project-based learning creates connections that actively engage students in deeper levels of comprehension and interpretation about what and how they study (Harada et al., 2008). With this in mind, many countries are moving away from the traditional teacher-centered approach where content knowledge is made visible to students, toward a more student-centered approach of learning where students have to be actively involved in the construction of knowledge (Liu et al., 2009).

Project-based learning embraces the integration of the set learning objectives from different subjects with the surrounding community and home-learned skills (Yuen, 2009). Each member, regardless of the levels of achievement, participates equally in the learning activities, thus leading to enhanced communication skills, decision-making, trust-building and conflict management (Cheng et al., 2008). Positive relationships and individual accountability are important because they provide students with the motivation to make sure that everyone in the group understands the materials, as the group is rewarded based on the individual achievement of each group member (Cheng et al., 2008).

According to Gultekin (2005), project-based learning integrates social cooperative learning and helps meet the diversity of learning styles that are present in today's classrooms. This approach allows students to analyze, criticize, and communicate collaboratively and gives them the responsibility for developing their own learning. When students believe they exercise control over significant events or they can produce desirable outcomes through their actions, they will have greater incentive to act, to expand effort and to persist at a given task (Cheng et al., 2008). As a result, project-based learning activities provide effective learning opportunities for struggling students who find traditional classroom activities difficult. When students overcome these difficulties and understand their work is a valuable, authentic problem that needs solving, or a project that will impact others, they are motivated to work hard (Solomon, 2003).

Students' sense of determination flourishes when they have some degree of power and control over classroom activities (Sanacore, 2008). It is also crucial learners have opportunity to obtain a sense of leadership in the learning process, where they make decisions regarding the pacing and content of learning, and where they also evaluate the desired versus actual outcome of their efforts (Papanikolaou & Boubouka, 2010). Project-based learning takes into account students' various learning preferences by allowing them to use a variety of resources to conduct their research (Bell, 2010). Project-based learning also allows students to use their abilities to decide how to approach a problem, and what tasks would best fit in the situation for practical application of skills to meet the need of that problem (Karaman & Celik, 2008). Therefore, it is essential to develop and cultivate students into being strong learners, with good reflective abilities on their own learning, so they may move forward and adopt practices that will allow them to define, plan, and self-monitor their thinking and learning from now into their future (Papanikolaou & Boubouka, 2010).

Project-based learning “refocuses education on the student and rewards intangible assets such as drive, passion, creativity, empathy, and resiliency” (Markham, 2011, pg. 39). Learners are encouraged to “be responsible for their own learning, to solve openended problems, and to create and present artifacts as demonstrations of their learning" (Ravitz, 2010, pg. 292). Liu et al. (2009) stated in their article on understanding students' motivation, that project-based learning has the potential to increase levels of student engagement and motivation when properly implemented within a classroom environment. This approach to education can increase interest for students, thereby maximizing the motivation, self-esteem, and value levels of the students, all which play into improving academic achievement (Kucharski et al., 2005). Classroom learning environments which are developing and cultivating project work also provide chances for students to use problem solving skills, make cross-curricular learning connections, and to be able to communicate concepts learned throughout the process (Wilhelm, Sherrod, & Walters, 2008).

Two of the earliest proponents of learning by doing, were Confucius and Aristotle (Crick, Stringher, & Ren, 2014). They also noted how "Confucius was among the first educators in history to have advocated the complementary relationships between learning and doing" (pg. 109). These educational leaders believed as many modern educators will agree, that the best way to learn is to put knowledge into practice, get in and get your hands on the materials and put knowledge into action. Socrates modeled the methods of learning through questioning, inquiry, and critical thinking. These strategies all remain relevant in today's project-based learning classrooms. Move ahead to John Dewey, who was a 20th-century American educational theorist, who continued to endorse the belief that learning comes from a basis of experience and interest from the learner. In contrast, Dewey challenged the traditional view of the student as a passive recipient of knowledge, as he argued that students needed active and engaging experiences that simulate actual situations, to better prepare students for continual learning in the real world (Boss, 2011). Maria Montessori, an Italian physician and child-development expert, started a movement in the 20th century with her newer approach to early-childhood learning in comparison to those before her (Lillard, 2013). Montessori demonstrated that learning occurs through actual experiences students can remember and learn from, not just by sitting and listening to words being spoken in a room. Montessori was a pioneer for the concept that learning environments are essential to developed capable, adaptive citizens who are also problem solvers.

Swiss developmental psychologist Jean Piaget helped reinforce the concept of a person being able to make meaning from learning experiences at different ages. His insights were some of the foundational components that the constructivist approach to education were based from, which encourages students to build on what they through questioning, investigating, interacting, and reflecting on those experiences (Piaget, 1952). Vygotsky (1978) suggested learning is a social process and cognitive growth is enhanced by the varied learning experiences that each child brings into the classroom. In addition, the learner's mind can go through a type of training using with mental exercises much like the body goes through training with physical exercises (Howard, 2002). By using these mental exercises for learning, children begin to question the world around them and how things within this world work. Mental exercises allow for students them to think creatively to answer these questions through active investigation (Helm, 2004). In addition, students need chances to develop knowledge by solving problems through asking questions, conducting investigations, drawing conclusions, and reporting findings (Savery, 2015).

Grant and Branch (2005) indicated in project-based learning, "Students are expected to construct individual strategies to examine problems and suggest solutions" (pg. 67). Project-based learning is a "potentially powerful means to produce relevant and rigorous learning that brings curriculum in line with the way the world really works" (Harada et al., 2008, pg.15). This type of learning style integrates traditional subject specific objectives with authentic learning environments, therefore "enhancing understanding which is developed through application and manipulation of knowledge within context" (Eskrootchi & Oskrochi, 2010, pg. 238). Markham (2011) stated in his project-based learning article that it is essential for students to demonstrate the ability to carry out the learned skills within the workplace for their future, so the learning environment should emulate this environment so students can be self-starters towards getting a task accomplished. "Students flourish under this child-driven, motivating approach to learning and gain valuable skills that will build a strong foundation for their future" (Bell, 2010, pg. 41).

Baker and White (2003) conducted a study within an eighth-grade science class, where two versions of a 2-week project-based learning unit were designed, implemented, and evaluated within this science class, which incorporated technology. The measured skills were attitude and student self-efficacy through science, using technology, as well as the academic achievement of the students. The study was conducted using two eighth-grade science teachers, their combined 10 classrooms, which serviced all eighth-grade students (*N* = 192), using two different note-taking methods. The first teacher had 87 students in the study, with 51 students in Group A, 36 in Group B. The second teacher had 105 students in the study, with 42 in Group C, and 63 in Group D. The results revealed that students from Group A showed a significant increase in their self-efficacy toward science (p <.01) and attitudes toward technology (p <.001). However, the results revealed that their attitudes toward science or self-efficacy toward technology did not change throughout this study. Students showed a significant increase in their attitudes related towards making personal decisions from the scientific data, as well as an increase in analyzing scientific data in different ways (Baker & White, 2003). Students from Group B showed a significant increase in their attitudes toward science (p <.05) as well as in their attitudes towards drawing conclusion from scientific data (p = .01). Student attitudes in Group C and Group D did not show a significant increase in attitudes or self-efficacy in science or in technology self-efficacy. The students in Group C and Group D did, however, show a significant increase in the students' attitudes toward technology (p < .05). Students of the first teacher (Group A and B) did show a significant increased within each of the four factors. Also in this study conducted by Baker and White (2003), the students showed an overall significant increase in their technology attitudes (p < .01), technology self-efficacy (p < .05), science attitudes (p < .05), and science self-efficacy (p < .05).

Students who have more positive self-efficacy beliefs (i.e., they believe they can do the task) are more likely to work harder, persevere, and ultimately achieve at higher levels (Linnenbrink & Pintrich, 2002). This related back to the current study in that it showed the right combination of techniques in application with a subject area and objective must be found, in order to have the maximum result desired as the outcome. Here, active learning techniques in a science classroom would build up self-efficacy in some ways, and attitude toward chunked parts of the activity in others. The data from this study acted as a foundation for the current study to focus on attributes that could possibly increase student attitude and motivation in a mathematics classroom.

Project-based learning relates to the current study in that it is the teaching method that was chosen to be implemented into an eighth-grade mathematics classroom to see if the skills, techniques, and activities used through project-based learning will have an impact on the mathematic success, or achievement of the students. Students need to see relevance of their tasks, and how they can transfer over into the real world through actual-place scenarios. Without the ability to transfer the skills into actual situations, the learning ceases to be relevant thus will not stay within long-term memory. Project-based learning provides students with the collaborative group atmosphere to incorporate teamwork along with individualized skills, both of which must be present successfully complete a project. This new perspective of student-centered learning could possibly be the link that is missing inside mathematics classroom that will show students relevance, thus boosting their motivation to learn the concept and master the skill through the end project result.

Academic Achievement

For students to become successful in the classroom, they must acquire the self-awareness and knowledge to take action when they fail to understand a concept presented in class (Zimmerman, 2002). Students who feel they fail to understand a concept can develop a sense of stress and anxiety over the subject area, causing them to be less successful due to their own anxieties. Mathematics anxiety is a huge issue for many students, and failure to grasp a concept can lead to anxiety, which can cause a student to feel like a failure (Tobias & Selman, 1978). For some students, physiological symptoms become present, such as a sickening feeling rising up from the pit of their stomach at the mere mention of the word ‘math’. Other students are inhibited by the psychological symptoms of self-deprecating thoughts, along with the flood of negative mathematical memories from their previous school years. Many factors, such as past mathematics class performances, can contribute to this overwhelming math anxiety (Alexander & Cobb, 1984). All math students are distinct, and some have distinct types of mathematical anxiety that can be triggered by different aspects of mathematics (Bessant, 1995).

Based on previous performance, each math student develops a unique math self-efficacy – a students’ beliefs regarding his or her ability to perform mathematical tasks effectively. This development of self-efficacy, in turn, has an impact on how academically successful a student strives to be in class. Project-based learning works alongside academics to enable students to acquire the ability to identify, access, and process important information and use their findings to solve real-life problems and build new knowledge that will make them successful (Chin & Chia, 2004). Real-life problems, which may result in permanent knowledge, are thought-provoking and enable the students to become emotionally involved, while increasing their chances to be successful in the subject being taught (Gulbahar & Tinmaz, 2006; Helm, 2004). Academic achievement is the mark of a students’ success in school, and the techniques implemented through project activities can make learning more enjoyable while enhancing higher order thinking skills by placing more academic responsibility on the students (Gultekin, 2005).

Meaningful experiences through project-based learning enable the students to use higher order thinking skills that will increase their academic as well as their interpersonal skills (Helm, 2004). Also, through mutual interactions with peers, the students' problem solving strategies can be enhanced, thus leading to academic as well as social accomplishments (Wentzel & Watkins, 2002).

Research studies show that “keying in on academic achievement through project-based learning has been widely researched and used in classrooms since the 1970s” (Slavin, 2011, pg. 344). Zakaria and Iksan stated in their 2007 article on promoting cooperative learning within science and math education, that through their research they have seen that over the years, “extensive research has been conducted on the use of cooperative learning in mathematics instruction” to show its benefits and need of implementation in modern classrooms to aid in academic improvement (pg. 37). The research on project-based learning techniques, specifically on the area of mathematics achievement has predominantly shown a positive correlation. Dwyer, Hogan, and Haney (2014) stressed group work, as a learning technique, has positive effects when correctly implemented in the mathematics classroom. Johnson et al. (2013) reviewed 68 studies comparing cooperative learning-style group projects to traditional styles of instruction, such as teacher-led classrooms with individualized work practice through textbooks. The reason they reviewed these studies was to focus on student achievement, so they could strengthen the case for using cooperative learning in math to help improve student achievement. Johnson et al. (2013) found the use of project-based learning groups such as are seen in cooperative learning facilitated learning in an active rather than a passive way. In addition, they claim working in these groups must be utilized in mathematics classes in order to help students think mathematically about the instruction, as it provides a level of understanding towards the relationships among various mathematical formulas, and apply their learned mathematical knowledge.

Advocates of project-based learning state its use can have positive effects on student achievement, social skills, motivation, self-esteem, and standardized test scores in the area of mathematics, especially in middle school. Middle school years are the foundation for all the concepts that are expanded and built upon in high school, so creating a solid academic foundation is crucial for both students and teachers. Without a strong foundation, and strong confidence built within students, academic success will not happen. A plethora of research studies in K-12 classrooms has produced evidence that students participating in learning groups tend to have higher academic test scores (Johnson & Johnson, 1999), a greater number of social skills (Gillies, 2002), higher self-esteem (Box & Little, 2003; Ellis & Whalen, 1990), greater comprehension skills (Palinscar & Brown, 1989), and fewer stereotypes of other ethnic groups (Walker & Crogan, 1998). These studies also show students participating in cooperative learning activities outshine students who work alone (Knight & Bohlmeyer, 1990). Additionally, the use of cooperative learning in elementary math classes presents students with more opportunities to share knowledge and increase their self-confidence (Wickett, 2000).

Within the present study, techniques from cooperative learning groups intertwined with the activities of project-based learning were used to create a platform for academic achievement in mathematics for eighth-grade students. Too many students are being lost in these middle years, many of whom came into middle school academically behind, and apathetic toward mathematics. This study intended to bridge the performance gap that is present in the area of mathematics in middle school, and provided a positive solution for students and teachers that built up academics and motivation alike. In the study, the project-based learning skills and techniques were applied in such a way to show students the ability to transfer skills learned within a classroom out into the real-world, thus beginning a successful career path of their choosing. The data obtained revealed which techniques were more successful, so similar techniques were used to best incorporate the skills of all students. This data could lend to how teachers plan and differentiate their instruction to meet the needs of all students.

Mathematics Motivation

The key attribute of lifelong learning is learning motivation, which is not limited to the classroom, but extends into the real world (Crow, 2006; Harms & Knobloch, 2003). "Motivated learners look for personal satisfaction within both the learning process and the learning material, and these learners are more likely to take responsibility for their own learning, searching for meaning and understanding" (Daly & Moria, 2010, pg. 181). When students are actively involved in engaging, motivated activities, they become committed to learning skills presented in the classroom. Project-based learning activities enhance mathematics motivation and keep students productively engaged, thus motivating them to learn emerging academic skills (Helm, 2004; Stockdale & Williams, 2004). When students are allowed to choose components of interest to them while working in small groups, their self-motivation is strengthened (Hertzog, 2005). The opportunities for choices also allow the students to share their strengths and expertise with others, thus increasing their intrinsic motivation and increasing group dynamics through this shared knowledge (Gillies, 2002; Hertzog, 2005). Allowing students to invest in, and be a part of a group where conflicting views are welcomed strengthens and enables them to be motivated to continue being a part of the situation until the problem is solved (King, 2002).

Pitsi, Digelidis, and Papaioannou (2015) stated in their article about motivation that “autonomy is one of the three dimensions of the social environment” (pg.353). Therefore, it is realized there is a need for the enhancement of motivation in learning for students, because students should have the chance to make decisions about their learning through self-made choices within the learning environment (Black & Deci, 2000). In an environment where independence is nurtured, students are more likely to boast having a larger satisfaction of this need, therefore they have more reasons to get involved in the lesson in comparison with a more dictated learning environment (Yagci, 2016).

Project-based learning has the potential to build motivation in students because it provides opportunities for them to apply skills that they may not be able to apply in other settings (Kucharski et al., 2005). Motivation is also enhanced because of the respect for the decisions that each student brings to the group (De Lisi, 2012), as well as the desire to ensure that the needs of others are met during the group's investigation (Gillies & Boyle, 2005). The positive benefit that encouraging motivation in education has, is that it enables the students to establish relationships and build motivational and emotional well-being is a very important part in individual and group success (Gillies, 2002). Through active learning activities, engagement and interest increases among students and, in most cases, decreases the achievement gaps between groups of students (Hertzog, 2005). These hands-on activities within a group to create a designated project not only increases opportunities for success in subject matters, but also enhances the students' abilities to communicate with their peers (De Lisi, 2012).

Attitudes and abilities can be enhanced when students are able to regulate their actions and interests (Pugh & Bergin, 2005). Self-motivated learners are driven to succeed. They motivate themselves, and are proactive because they are aware of their strengths and weaknesses and are guided by set goals and strategies (Zimmerman, 2002). Mathematics motivation enables students to adapt to different learning tasks through implementing strategies to accomplish learning tasks, managing their time, and self-evaluating the methods used to finish the task. When students have high self-efficacy, they can understand deep information processing, while explaining their ideas to their classmates (Song & Grabowski, 2006).

Song and Grabowski's study set out to observe the effects project-based learning activities on mathematics motivation and problem-solving skills according to student self-efficacy levels, specifically by the type of goal-oriented context and by the peer groups the students were working within. It was hypothesized that students working in a learning-oriented context group would be more motivated and more effective problem solvers that those in other groups. The sample population consisted of 90 students (47 boys and 43 girls) within a sixth-grade class. The results of the self-efficacy pretest showed that no significant difference was found between participating classes.

Two weeks before the study, the self-efficacy text was administered to the treatment group. Students from the high-efficacy and the low-efficacy groups were randomly drawn and assigned to either a heterogeneous or a homogeneous peer group. Each classroom had 23-25 students, therefore consisted of 11 to 12 peer groups. The study was administered over three separate 45-minute sessions, where students completed the ill-structured problem-solving tutorial and then wrote an individual problem-solving report on paper. The students then completed questionnaires that measured the atmosphere of their peer group environment, goal orientation, and motivation.

In the study, students who took part in the learning-oriented context were anticipated to have a higher significance in motivation scores than the students who took part in the performance-oriented context. The analysis of variance (ANOVA) results showed the students in the learning-oriented context had a higher significant difference in intrinsic motivation scores (M = 3.39, SD = .69) than the students in the performance oriented context (M = 3.16, SD = .66).

The background and concept of motivation supported this study because it provided relevance as to the connection between performance-based activity outcomes and intrinsic motivation in students. Throughout the research studies, an increase in how students perceived themselves about the subject area is seen. Often heard is that some techniques that work for certain subjects cannot be transferred into other subjects, which could be true in some ways. This relates to the present study in the concept of project-based learning activities and techniques were tested to see if they can be successfully transferred across multiple subject areas to help ensure students' academic success.

Chapter Summary

In summary, Brown (2003) suggested because there are so many learning styles and abilities in a class, teachers must provide activities that vary widely regarding the skills needed to be successful. Also, by providing students with opportunities for active involvement, their abilities to retain very important information are enhanced (Linnenbrink & Pintrich, 2002).

Active learning involves students getting hands-on in their learning process. Active learning allows for student engagement in the learning process, and student motivation from this hands-on engagement. Through active learning, students can complete performance-based tasks with application of concepts, which prepares them to connect the relevance in what they are learning to things outside the classroom. The generation of today must be shown the practicality of the skill they are learning, and how to actively apply it to their lives. The more active the learning process is, the more involved the students' become, so that they can have an end result to show their application of the skill.

Active learning is conducted best when it is student-led. In student-centered learning environments, the teacher and students share equal responsibility in the decisions making process and overall working operations of the class. This form of interactive teaching models a frequent two-way communication for learning between the teacher and students. Here, students are encouraged to ask questions, offer suggestions, give input on a regular basis without fear of criticism, to allow the lessons to run smoothly, accounting for any confusion to be met and handled along the way. In the student-centered learning environment, "the teacher will ask for, and act upon, students' suggestions and ideas in class" (Metzler & Gurvitch, 2013, pg. 32). Student-centered learning provides a new way of approaching education, by giving more responsibility of the learning back to the students. Through project-based learning, the students are the drivers of the learning process, thus student-centered learning is the leader in the classroom.

Cooperative learning is another aspect of active learning to foster collaboration among students, which promotes a sense of responsibility to others that motivates all learners to persist and perform up to their potential (Pedersen & Williams, 2004). This collaboration in cooperative learning helps build the strong foundation of self-motivation and confidence within students when relating to ability and academics so the students know they do have the ability and can succeed. Cooperative learning groups are an asset to education, in they can be used cross-curricular to teach specific content, while working to ensure active cognitive processing of information from a lecture or demonstration through peer support (Johnson et al., 2013). Any course requirement or assignment may be structured cooperatively. When students learn to work together for a project goal, it begins to build the confidence and motivation needed to attempt more projects, and achieve more educational goals.

Project-based learning is an innovative teaching method of active learning that allows for the incorporation of a multitude of teaching and learning techniques critical for the success of students who are attaining knowledge within the technology age of the 21st century. Students have a desire to drive their own learning through their constant inquiry, as well as a desire to work collaboratively to create projects with outcomes that demonstrate their knowledge. From gaining new, viable technology skills, to becoming avid and proficient problem solvers, students benefit from this engaging approach to learning. Project-based learning offers positive results in increased involvement, determination, and motivation. It also enables the students to see themselves as learners while helping others in their class with their skills and abilities. When students become the center of their own learning, they take a sense of pride and ownership to their academic success which will build as they grow as a future learner.

Students' experiences in classrooms are critical to their motivation, attitudes, behaviors, and achievement (Schweinle, Meyer, & Turner, 2006). As students transition through education, they need to learn how to self-motivate to take greater personal control of their learning, which increases their chances of being successful (Dembo & Sell, 2004). Working collaboratively in groups to achieve a set task goal will lead to academic achievement for all group members working through project-based learning activities. The project-based learning teaching method offers various ways to address the needs of the students, which will motivate them to take control of their own learning in mathematics and all areas, and lead them to become more confident of their decisions (Lin & Hsiao, 2002).

Chapter III - Method

Introduction

The purpose of this study was to investigate the effects of project-based learning activities on mathematics motivation and academic achievement of eighth-grade middle school mathematics students. More specifically, this research focused on how the completion of project-based learning activities within a group setting affected the relationship between academic achievement and learning motivation in mathematics for eighth-grade students.

This study was conducted over 8 weeks during the first quarter of the school year. The study was conducted in the setting of a rural public school, and the target audience was eighth-grade students. The system-wide STAR math assessment test scores were used as a baseline to identify the percentages of students who were above, at, and below grade-level on their mathematics abilities at the start of their eighth-grade year. The students were divided into heterogeneous peer groups within their classes as they worked on certain assignments. These assignments consisted of hands-on, project-based math activities, and the results of the project-based activities were charted, graphed, or drawn. A project is defined as a representation of the objective selected that is constructed by students. After each task was completed, the groups were allowed to present their findings to the class. The treatment was administered in math classes two to three times per week as part of the class learning activities.

After the study, the students' test scores and motivation results from the posttest and post questionnaire were compared to the same elements on the pretest and prequestionnaire in order to determine if a statistically significant difference existed between the groups due to the treatment. Additionally, at the end of the study a time was set aside and the results of the study were shared with the administrators of the participating school. The following research questions directed this study:

1. Does the use of project-based learning activities incorporated into a middle school mathematics classroom show a significant difference in mathematics achievement scores for eighth-grade students?
2. Does the use of project-based learning activities incorporated into a middle school mathematics classroom show a significant difference in motivation for eighth-grade students?

All students in the selected eighth-grade classes were invited to participate in this study, and all data obtained was used as part of the research study. Participating students' names were coded by numbers, and their gender was coded F for female and M for male. If a student decided to withdraw from the study after it began, the information for that student was destroyed immediately.

Research Design

This study was a quantitative research study, using a quasi-experimental, nonequivalent comparison group design. This means that there was a pretest, posttest, and pre and post motivation questionnaire for both groups, but the groups lacked random assignment. The results of the study compared the scores of the pretest, pre questionnaire, posttest, and post questionnaire to see if a significant difference in the scores existed. The treatment group received the instructional teaching method of the project-based learning activities within their group. The control group was evaluated without this treatment factor. Included in this research was the comparison of the effect of the two independent variables, traditional instruction and project-based learning activities as teaching methods, on students’ academic achievement and motivation in mathematics.   Table 4 presents an overview of this research design.

Table 4

Quasi-Experimental, Nonequivalent Comparison Group Design

Pretest/MSLQ	Group	Posttest/MSLQ
O	X_{PBLA}	O
O	$X_{without\ PBLA}$	O

Note: PBLA = project-based learning activities are implemented; Without PBLA = no project-based learning activities are implemented; O = measurable occasions; X = group

The quantitative aspects of this research design focused on how the treatment affected the students' academic achievement on chapter assessments. Controlling for the pretest, the posttest scores were compared in order to measure the difference in the scores. The students' responses on a Likert scale questionnaire, known as the Motivated Strategies for Learning Questionnaire, or MSLQ, (Appendix A) were also analyzed in order to evaluate any changes in the participants' motivation.

Independent Variables, Dependent Variables, and Covariate

The independent variables in this study were the types of instructional teaching methods, traditional and project-based learning activities. One group received the traditional teaching method, while the other group received the project-based learning activities method of instruction in mathematics classes. Both groups received CCRS objective-based skill lessons, a pre and posttest, and a pre and post MSLQ. The treatment group also received project-based learning activities as their instructional practice, which were skill-based activities. The dependent variables in this study were students' academic achievement measured by a mathematics posttest, and students' mathematics motivation to be measured by the MSLQ. The covariate that was controlled for was the pretest scores.

Participants

The study took place in Southwest Alabama in a rural school setting. The rural school serves grades 6-8, with a total population of 1,632 students, 571 of which are in the eighth grade. The population for this study consisted of approximately 124 eighth-grade students within general education classroom settings. According to the National Center for Educational Statistics (2013), 72.8%, of the students at the school were considered economically disadvantaged. Of the economically disadvantaged population, 88.8% are impoverished. An ethnic breakdown consists of 75.6% Caucasian, 21.5% African American, 1.6% Hispanic, 0.3% Asian/Pacific Islander, and 0.8% American Indian/Alaskan Native/Multiple Races (National Center for Educational Statistics, 2013).

The four classrooms that made up the two groups were a mixed variety of ability levels, ranging from middle to high. The middle to higher range ability level students consisted of general education students spanning a range of mathematical abilities, some of which qualified for all areas of advanced education based upon intelligence levels. In this school, project-based learning techniques had not been experienced previously by the student population. This study was the first exposure the participants had to formal project-based learning. This factor provided more reliable data, as it was exposure to the techniques with results in the truest form, first exposure. The motivational level of this population was low toward the subject of mathematics. To gain a baseline of student ability, the previously administered STAR math assessment scores were pulled to show the starting abilities of these eighth-grade students. This assessment is an online test that adjusts to the abilities of the students throughout, in order to determine the working mathematics level of each student. The data from this assessment showed that a large portion of the population, 45% in fact, were beginning their eighth-grade year already at below average STAR math assessment scores, per the STAR math assessment test given test given quarterly in the school system (Table 5). When asked about the subject of mathematics, the students in the population showed visual signs of frustration and distaste for the topic and subject matter of mathematics.

Table 5

STAR Math Assessment Results

Level	Total	Percentage
Above Grade Level (>8)	61	49%
At Grade Level (=8)	18	14%
Below Grade Level (<8)	45	36%

Note: N=124, n=45 for below grade level

Materials

Instructional content of the project-based learning activities consisted of instructional learning objectives standards aligned with CCRS, ALSDE, and MCPSS courses of study. These objectives were pre-selected as being required to master for this grade level by those educational organizations. All lessons during the study included instructional practice of these standards. For the treatment group, the method of instructional practice were the project-based learning activities that lended themselves to opportunities for the participants to work in groups to accomplish particular tasks. Cooperative behaviors that were observed during the research included task and socially oriented behavior and how participants' active attention to others affected the group dynamics.

Motivated Strategies for Learning Questionnaire (MSLQ). The MSLQ was used to measure any changes in the participants' motivation. The MSLQ is a modified Likert-scaled instrument that is designed to assess motivation and focus in the areas of the following three scale components: intrinsic goal orientation, task-value, and self-efficacy for learning and performance. In addition, the instrument shows reasonable predictive validity to the actual course performance of students. The original format of the MSLQ consists of 81 items over the three scale components. For this study, some items were excluded from the scales because of a lack of correlation to the study, thus the term modified is used in the description. For this current study, 18 of the original 81 correlated to the study, and were used as the MSLQ.

The MSLQ was developed by a team of researchers, Pintrich, Smith, Garcia, & McKeachie (1991), from the National Center for Research to Improve Postsecondary

Teaching and Learning and the School of Education at the University of Michigan. The MSLQ was tested by these researchers by running two confirmatory analyses: one for the set of motivation items and another for the set of cognitive and metacognitive strategy items. The questionnaire demonstrated a predictive validity with alphas ranging from .52 to .93 (Pintrich et al., 1991). This questionnaire was given before and after the treatment in order to record any changes in motivation or the participants' management of effort during the group project activities. The average scores from the three scaled subsections of the pre and post MSLQ were compared to determine if learners expressed different levels of mathematics motivation before and after the treatment of the study.

Eighth-Grade Project Skill Test. The pretest and posttest that aligned with eighth-grade mathematics objectives were used to evaluate the participants in this research (Appendix B). These tests were created by the researcher. The skills on these tests aligned with the national and state standards and allowed for skill enhancement that focuses on the objectives assessed on the Grade 8 state standardized test. Also, these tests included problem-solving skills needed in state testing and provided students with real-world scenario problems to fully master the concept. Controlling for the pretest scores, changes in the participants' mathematics achievement were determined by analyzing math scores of the posttest. These grades were examined to search for trends in the math achievement improvement or decline of the participants.

Project-Based Learning Activities. The project-based learning activities that were implemented by the researcher to the treatment group were aligned to the objectives set down by CCRS and state standards. A list of 15 project options was given and the student groups selected from them to begin their work. (Appendix C).

Procedures

Institutional Review Board. A proposal requesting permission to conduct this research study was sent to the University of South Alabama's Institutional Review Board (IRB) (Appendix D). An application requesting permission to conduct this research study within a public school was sent to Mobile County Public Schools (MCPSS) (Appendix E). Permission was acquired from principal of the school identified for the study to access the students' grades and other critical information. The researcher also met with the principal of the school and discussed the aspects of the research and gained consent (Appendix F).

Participant Consent. Students in eighth-grade mathematics were invited to participate in this 8-week research study during their designated class period. Before participating in the study, students were informed that involvement in the study was completely voluntary. The researcher developed a written consent form for the student participants to return (Appendix G). The researcher distributed the consent forms with the classroom pacing guide (Appendix H), and the students were instructed to obtain parental signatures and return as soon as possible. This form was passed out on the first day of the class, August 10, to ensure prompt return of the forms. Students were directed to return the form by the end of the week. The consent form provided the parents and students with information about confidentiality, purpose, and procedure of the study.

Development of Materials. Before the study could be conducted, the researcher worked with the CCRS and MCPSS mathematics pacing guide to create the standards-based lesson plans (Appendix I) for the 6 weeks of the treatment period. The lesson plans were made to deliver the same whole group instruction to both groups, and allotted for the instructional method of practical application to differ between the two groups. The standards-based lesson plans gave a detailed format of the steps taken by the teacher guiding the groups. All instruments were designed by the researcher and were reviewed and modified as needed by a team of mathematics teachers for content validity.

Pretreatment Assessments. The first week of the study was used to administer pretreatment assessments, specifically the second day of the class. The teacher began class by giving an explanation of the rationale of the test, encouraging students to put forth their best efforts in responding. Both groups took the assessments, for a common, controlled starting point for comparisons of the intended treatment. After preparing the classes, the teacher administered the eighth-grade project skills test pretest and the MSLQ. The project skills pretest was given first, and was composed of 10 questions ranging over 14 national and state objectives that are typical prerequisites in mathematics for eighth-grade students. This assessment was given at the start of the class period, to allow for ample time for each student to complete to their own satisfactory. After the pretest, the MSLQ was administered to each class, to allow them to record their feelings about mathematics and their own mathematical abilities prior to the treatment being introduced. The MSLQ was administered to both groups, to serve as another commonality point by which to compare the two groups on motivation levels of this eighth-grade as a unit. These average of the subsets of the MSLQ results were collected, analyzed, and recorded. At the conclusion of the study, the results were reported to the head of the mathematics department for the school, as well as the administration, for future improvements or suggestions.

Assignment to Groups. The participants for this study were part of a convenience sample, and there was no random assignment into the groups because of their prior placement within classes this school year. There were four classes evaluated in this study: two made up the one control group, and two made up the one treatment group. Classes were preassigned based upon placement within the school by the counselors at the start of the semester. All classes were evenly dispersed by age, race, gender, and academic ability. The control group completed the pre and posttests, pre and post MSLQ, and received traditional classroom instruction and practice of mathematics over the span of the 6 weeks of lesson instruction. The treatment group also completed the pre and posttests, pre and post MSLQ, but they received the treatment of project-based learning activities (PBLA) as their form of instructional practice method during the span of the treatment period.

Treatment Period. The complete study time frame of 8 weeks from start to finish. The study started on August 11th, during week 1, with the administrating of the pretest and pre MSLQ. Over the following 6-week period, the groups received standards-based lessons during whole group instruction, with the treatment group completing PBLA as their form of instructional practice method during their mathematics class. The control group continued to practice the instruction in the traditional format, being individual seatwork given by the teacher. The final week, week 8, was set aside to administer and evaluate the posttest and post MSLQ. For all classes, the class periods ran an average of 60 minutes in length.

Traditional instruction classrooms. Traditional instruction classrooms began with teacher-led direct instruction. Through direct instruction, the teacher introduced and modeled the named learning objective to the students. After this first delivery of instruction, the classroom moved into the guided practice portion of the instruction. In guided practice, the teacher modeled the application for the students, asking questions along the way, and prompting students to put thought into the reason behind their response. This is the time where the teacher and students communicated with one another to help develop understanding about the materials. Finally, the classroom shifted into independent practice where the students applied the mathematics skills on their own, usually with a paper and pencil method form of response sheet. This daily teaching method was repeated on a weekly basis, over the span of the 6 week treatment period.

Project-based learning classrooms. In the project-based learning classrooms, teacher-led direct instruction was the driving force to begin the lesson. Similar to the traditional instruction classrooms, the teacher presented the objective to all of the students through whole group instruction. Then the classroom moved into a blend of guided practice and independent practices. First the teacher modeled a few examples of problems, dealing with the named objectives. From there, the teacher moved into a more passive role of facilitator, as the students broke into their groups and selected their project from the master list of project options. The student-centered instruction of these learning groups applying mathematics objective skills in a performance-based setting served as the independent practice within these classrooms. This daily teaching method was repeated on a weekly basis, over the span of the 6 week treatment period.

Post-treatment Assessments. On the 8th week of the study, the teacher administered the eighth-grade project skills posttest, which was identical to the pretest so that there were no discrepancies in the results. Both the control and treatment groups completed the posttest along with the post MSLQ during the 8th week of the study. These posttest scores were analyzed to check for significance in mathematics achievement due to the treatment.

Teachers in the study evaluated the fidelity of implementation. Fidelity of implementation is the degree that the major components of a proposed program were presented during the programs implementation (Century, Rudnick, & Freeman, 2010). For this study, fidelity of implementation was used to measure the execution of the intervention itself. In order to measure this, a Fidelity of Implementation Form (see Appendix J) was used by teachers involved in the study. The form was modified from the framework of implementation (Century et al., 2010). The form is based on the critical components dealing with the particular context of the study.

Data Analysis

Data analysis of the tests and MSLQ were conducted using the Statistical Package for the Social Sciences (SPSS). SPSS calculates the descriptive statistics. Controlling for the pretest scores, an analysis of covariance (ANCOVA) was used to assess the difference between the two groups academic achievement based on the posttest scores. To assess the students' motivation responses, a one-way analysis of variance (ANOVA) was used to evaluate the mean of the difference between the two groups. An ANCOVA was performed with students' achievement as the dependent variable, and controlled for the covariate of the pretest scores. The independent variable will be the type of teaching method applied, traditional or project-based learning activities.

Chapter Summary

This research study used a quasi-experimental, nonequivalent comparison group design. It examined if there was any difference that project-based learning activities as an instructional method seem to have on students' academic achievement and motivation in mathematics. The independent variable was the type of instructional teaching method the groups received: traditional or project-based learning activities. The dependent variables were the students' academic achievement and motivation. Students' academic achievement was measured by the data results of the comparison of the pre and posttest scores. Students' motivation was measured by the averaged subset scores from the pre and post MSLQ.

The participants of the study were students currently enrolled in eighth-grade mathematics classrooms in a rural middle school. Students were asked to participate on a voluntary basis. Participants completed a pre and posttest, and pre and post MSLQ. The treatment group also received in introduction and incorporation of PBLA into their classroom instruction. The quantitative data was statistically analyzed using SPSS. The results of this research study may enable teachers to use projects to differentiate their teaching methods and assessment methods in mathematics in the future.

Chapter IV – Results

Introduction

The purpose of this study was to introduce and incorporate the instructional teaching method of project-based learning activities into middle school mathematics classrooms. The study used a quasi-experimental, nonequivalent comparison group research design. Students were previously placed within classes for the school year, so no there was no random assignment of students to the control or treatment group. Both groups received a pretest, and a MSLQ before the treatment period; 6 weeks of mathematics standards-based lessons during the treatment period; a posttest, and a MSLQ after the treatment period. The difference between the two groups was the type of instructional teaching method used for the application and practice portion of the mathematics lessons. The control group received a mathematics standards-based lesson that used a traditional classroom instruction practice method of individualized mathematics application, usually in the form of bookwork or a worksheet. The treatment group received the same lesson and implemented project-based learning activities as their instructional teaching method to apply the mathematic skills into practice.

The results of the quantitative data analysis are presented based on the research questions. The quantitative data were analyzed using SPSS. For the inferential statistics analysis in this study, the alpha level used to determine significance was .05.

Teacher Fidelity of Implementation

After the treatment was implemented, the teacher involved in the study was asked to fill out a Teacher Fidelity of Implementation form. The purpose of this form was to measure the implementation of the treatment. The questionnaire had three components of measure: procedures, pedagogy, and student engagement. The procedural components included staying on the time schedule, the use of the assessment tools, and following the structure of the given lesson plans. The pedagogical components included teacher-facilitated cooperative learning in the PBLA group, teacher-facilitated class discussions in traditional instruction group, and student autonomy in both groups. The student engagement components included how the students in the control group engaged in class discussion, and how the treatment group contributed in their cooperative group work and toward project completion.

For each component, the teacher was asked to rate specific items on a scale of 1 – 5 on the degree to which she implemented the item in her classroom during the research study. The teacher fidelity results of the implementation form revealed that the teacher stated she adhered to all procedural, pedagogical, and student engagement components to the highest degree, meaning she accomplished the specified items very often throughout the days of the research study. The teacher said that students in the treatment group were very motivated and interested in the lessons throughout the 6 weeks. Many of the students expressed their enjoyment of the ability to be creative in their mathematics practice through the project activities, as well as through the collaboration with peers to accomplish the project goals. Several students asked her if they could continue doing math through projects rather than going back to book practice and pencil/paper assessments, as it was enjoyable and showed relevance of math to real life. The teacher stated she was pleased with the high level of motivation and enthusiasm for math that she witnessed from the students through the PBLA lessons. The teacher expressed her desire to learn more about PBLA and seek additional training in this area to be able to successfully include it more into her classroom, because of the effect PBLA had on the students' motivation. The teacher stated that the control group students were moderately interested in the standards-based lessons, but disliked the fact they did not get to partake in the PBLA like the other group. This group completed the given traditional instructional practice from their text and/or teacher-designed worksheet as part of their instruction, but did not have the same enthusiasm about learning the math skills. The teacher made the observation that the motivation level was drastically lower in the control group, and this group daily expressed their desire to work with peers and complete projects on the skills, rather than the book work practice. A copy of the teacher's responses to the questionnaire is located in Appendix K.

Quantitative Analysis

In order to answer this study's research questions, the quantitative data were analyzed using SPSS. Some data from the study were missing due to student absences, but no differential attrition was noticed.

Research Question 1. Does the use of project-based learning activities incorporated into a middle school mathematics classroom show a significant difference in the mathematics achievement scores for eighth-grade students?

An ANCOVA was conducted, controlling for the pretest scores, to investigate the impact of PBLA as an instructional teaching method on the posttest scores of a middle school mathematics classroom. In order to determine if the homogeneity of slopes assumption was met, the analysis was run with and without the interaction between a group and the covariate (i.e. pretest). The interaction between the independent variable and the covariate was not statistically significant F (1, 73) = .23, p = .63. As a result, the homogeneity of slopes assumption was not violated and the analysis was carried out without including the interaction.

The results of the ANCOVA showed that there was no statistically significant difference between the two groups on posttest scores F (1, 60) = .05, p = .87. There was a significant relationship between the pretest and posttest scores. The strength of the relationship between the posttest and pretest scores, as assessed by eta-squared, equaled .33, a moderate effect size. Approximately 33% of the posttest scores' variance was explained by the pretest. Table 6 displays the means and standard deviations of posttest scores for participants in both the control and treatment groups.

Table 6

Means and Standard Deviations of Participants' Posttest Scores by Group

	Pretest			Posttest		
Group	*n*	*M*	*SD*	*n*	*M*	*SD*
Control	62	72.66	25.22	60	77.52	19.12
Treatment	62	66.87	22.01	59	71.24	24.1

Note. Total points available were 100.

Research Question 2. Does the use of project-based learning activities incorporated into a middle school mathematics classroom show a significant difference in motivation for eighth-grade students?

Research Question 2 was investigated using quantitative data from the Motivated Strategies for Learning Questionnaire (MSLQ). The MSLQ is comprised of items spanning three component subsets: intrinsic goal orientation, task value, and self-efficacy for learning and performance. The MSLQ was administered to each participant as part of the pre and posttest to measure student motivation about mathematics. Students rate themselves based on their behavior, on a seven point Likart scale from “not true at all” about me to “very true” about me. Scales are constructed by taking the mean of the items that make up that scale. This scale average of the sums for each component on the MSLQ was used to represent that portion of the test. Table 7 displays the three component subset breakdowns from the MSLQ for this study, along with the sample question items from the questionnaire.

Table 7

MSLQ Subsets and Sample Items

Subsets	Sample Items
Intrinsic Goal Orientation	1. I prefer work that is challenging so I can learn new things. 2. I prefer course work that makes me curious, even if it is difficult. 3. The most important thing for me is trying to understand the lessons in the class. 4. I choose assignments that I can learn from even if they don't guarantee a good grade.
Task Value	5. I think I will be able to use what I learn in this class in other classes. 6. It is important for me to learn the material in this class. 7. I am very interested in the lessons in this class. 8. This class material is useful for me to learn. 9. I like the subject matter in this class. 10. Understanding the subject matter of this class is very important to me.
Self-Efficacy for Learning and Performance	11. I Believe I will receive an excellent grade in this class. 12. I am certain I can understand the most difficult material presented in the reading for this class. 13. I am confident I can learn the basic lessons in this class. 14. I am confident I can understand the most complex material presented by the teacher. 15. I am confident I can do an excellent job on the assignments and tests in this class. 16. I expect to do well in this class. 17. I am certain I can master the skills being taught in this class. 18. Considering the difficulty of this class, the teacher, and my skills, I think I will do well in this class.

Note. The subsets divisions for the MSLQ completed by the students in the study.

A one-way analysis of variance (ANOVA) was conducted to see if there was a significant difference between students' motivation toward learning mathematics between the control and treatment groups. The ANOVA used the average scores for each of the three component subsets from the pre and post MSLQ to determine if the mean of the difference between the two variables were significantly different. The scores from the pre and post MSLQ acted as the dependent variables, while the independent variables were the two instructional teaching methods: traditional instruction and project-based learning activities. The scores on the three subsets were evaluated based on the participants' responses toward their level of motivation toward mathematics before and after the treatment period.

On the MSLQ subset of items dealing with intrinsic goal orientation, the control group's mean pretest score of 7.12 was lower that their posttest score of 7.20 for the same subset. The treatment group's mean pretest score in the same subset was 7.24, which was lower than their posttest score of 7.58. Likewise, on the task value subset on the MSLQ, the control group's mean score of 6.25 was slightly lower than the mean score of the posttest of 6.28. The treatment group's mean pretest score in the same subset was 6.13, and increased to the posttest mean score of 6.75. In addition, the control group's pretest mean score of 6.01 in the self-efficacy subset was higher than then posttest mean score of 5.48. Similarly, the PBLA group's self-efficacy pretest score mean of 6.05 is comparable to the posttest score mean of 5.97 as shown on Table 8.

Table 8

MSLQ Subsets Data

	N	*M*	*SD*	Sig	*df*
<u>Intrinsic Goal Orientation</u>					
Control Group					
Pre	62	7.12	1.335		60
Post		7.20	1.124	.003	
Treatment Group					
Pre	62	7.12	1.457		59
Post		7.20	1.054	.000	
<u>Task Value</u>					
Control Group					
Pre	62	6.13	0.954		60
Post		6.75	0.740	.462	
Treatment Group					
Pre	62	6.25	1.058		59
Post		6.28	1.210	.000	
<u>Self-Efficacy for Learning and Performance</u>					
Control Group					
Pre	62	6.01	0.975		60
Post		6.75	0.832	.000	
Treatment Group					
Pre	62	6.05	1.257		59
Post		5.97	1.304	.000	

Note. **p* < .05. Data from the MSLQ results from the study.

The results of the one-way ANOVA showed that there was not a statistically significant difference between the treatment and control groups on students' mathematics motivation $F(1, 59) = 1.53$, $p = .22$. Table 9 displays the means and standard deviations of post MSLQ scores for participants in both the treatment and control groups.

Table 9

Means and Standard Deviations of MSLQ Math Motivation by Group

	Presurvey			Postsurvey		
Group	*n*	*M*	*SD*	*n*	*M*	*SD*
Treatment	36	8.25	2.52	32	8.66	2.43
Control	35	7.90	2.55	34	7.97	1.91

Note. Total points available were 18.

Chapter Summary

This chapter presented the methods that were used to analyze the quantitative data from this research study. The results of these methods were also presented. In regard to student achievement, the quantitative analyses showed that there was not a statistically significant difference between the control and treatment group on the overall posttest. Analysis also showed there was no statistical significance between the treatment and control group in relation to mathematics motivation. Students differed in their motivation levels in regard to motivation to learn mathematics, in which the treatment group rated higher in motivation than the than the control group. The results of all of these analyses will be discussed in Chapter V.

Chapter V – Discussion

Introduction

The purpose of this chapter is to discuss the results and implications of this study. The study focused on the effect that the instructional teaching method of project-based learning activities had on achievement and motivation of middle school mathematics students. This chapter presents a summary of the results, interpretation of the results, and possible causes of the results as they relate to the research questions. The limitations and strengths of the study, implications for instructional designers, and recommendations for future research are also presented in this chapter.

Discussion of Research Questions

The purpose of the research study was to introduce and incorporate the teaching method of project-based learning activities into middle school mathematics classrooms. The effects of this form of active learning were monitored to determine if its incorporation had a significant impact in the difference of eighth-grade student's academic achievement and motivation toward mathematics. During the 8-week study, participants received a pretest and a MSLQ the first week of the study. The following 6 weeks of the study consisted of weekly standards-based lesson breakdowns, with an average minimum of two standards per week. Throughout the mathematics lessons, students received whole group instruction and then worked individually or broke into groups to practice the concepts. During the last week of the study, students received a posttest and a MSLQ. Participants in four mathematics classes were divided into two groups; one control group which received traditional instruction teaching practice methods of individual work, and one treatment group which received project-based learning activities as their form of instructional practice method. This study was conducted to explore the effects of project-based learning activities on students' achievement and motivation. The two main research questions were related to the two dependent variables, achievement and motivation. The first research question related to achievement, and was based on the score comparisons of the pre and posttest. The second research question related to motivation was based on the response results of the Motivated Strategies for Learning Questionnaires.

Research Question 1. Does the use project-based learning activities incorporated into a middle school mathematics classroom show a significant difference in the mathematics achievement scores for eighth-grade students?

There was not a statistically significant difference on the posttest between the control and treatment group. The results were contrary to much of the research on cooperative learning compared to traditional learning, which claimed that cooperative learning produced higher academic achievement (Dat Tran & Lewis, 2012; Foley & O'Donnell, 2002; Kose, Sahin, Ergun, & Gezer, 2010; Lucker, Rosenfield, Sikes, & Aronson, 1976; Sherman, 1994; Springer, Stanne, & Donovan, 1999; Whicker, Bol, & Nunnery, 1997; Yager & Tamir, 1993; Yager, Johnson, & Johnson, 1985).

Several factors could have contributed to this result, such as the students' social interactions, outside interacting forces (i.e. classroom interruptions, assemblies, unscheduled drills), and the teachers' ideological beliefs. Students in the classrooms expressed they enjoyed the project-based learning activities because they got a chance to work, socialize, and learn from their friends. According to Bergin (1999), if students are distracted with friends and socializing during group work they are not likely to achieve proficient understanding of the content. Students may not have experienced the full benefits of achievement with cooperative learning due to focus on socializing; therefore there were no differences between the control and treatment group achievement scores. Also, students had recently begun using cooperative learning groups in class through this research study, so had no prior knowledge of these types of formal cooperative groups being used through a mathematics classroom environment. Students have worked in informal cooperative learning groups before, at some point in their formal schooling, but not on a consistent, daily basis as with this research study. Students may have been novices at working in groups and without knowing how to stay on task, share, and collaborate in cooperative learning they did not succeed as well as they may have otherwise.

Guskey (1986) stated that teachers' beliefs and attitudes about learning come from their own classroom experiences from their school years. In general, teachers teach the way they were taught, which was primarily by teacher-led instruction, followed by pencil/paper drills to allow students to practice the instruction. In the last 20 years, studies have been conducted in many countries to determine the technical and personal abilities required of engineers by today's industry. Mills and Treagust (2003) stated through their article that these studies have indicated some key concerns. Engineering graduates of this century need to have strong communication and teamwork skills, but it is being found that they do not have these skills. They also need to have a broader perspective of the issues that concern their profession such as social, environmental and economic issues. Mills and Treagust (2003) also reported that these engineering students are graduating with good knowledge of fundamental engineering science and computer literacy, but they do not know how to practically apply the knowledge. Many teachers do not see cooperative learning activities as a way to increase students' achievement, but rather as a way to increase social and personal development. After the completion of this study, the cooperating teacher stated she would use the project-based learning activities lessons again because students found them motivating. Even though the teacher noticed the lessons slightly increased achievement, motivation was considered by this teacher to be more important. This ideological belief about cooperative learning may have influenced the teachers' classroom behaviors and practices, which in turn may have affected the results of the study.

Even though the two groups in the study received different types of instructional teaching practice, traditional or project-based, both groups received the same amount of whole group content instruction from the teacher. The whole group lesson was presented at the beginning of the class periods for 25 minutes, where the teacher taught the content using a traditional teaching method, and for the remaining 35 minutes of the class period, students practiced the skills of instruction. The control group practiced instruction through traditional, individualized methods of work, while the treatment group practiced through the project-based learning activities. The majority of the whole group instruction to the students in both groups was teacher-centered using lecture and demonstration when the teacher taught the content.

Although there was not a statistically significant difference between the control and treatment group on the posttest, it was noticed that both groups did experience increases in their mean scores from pretest to posttest scores. This was not a surprise because students were taught the content between the pretest and posttest, and gained a deeper understanding of the mathematical content. An increase in meaningful learning will mostly likely increase students' achievement because meaningful learning allows information to be stored more quickly and remembered more easily for retrieval (Taylor & Parsons, 2011).

Research Question 2. Does the use of project-based learning activities incorporated into a middle school mathematics classroom show a significant difference in motivation for eighth-grade students?

There was a statistically significant difference in students' mathematics motivation to learn mathematics between the control and treatment group. The treatment group had a higher motivation level than the control group. On the MSLQ, students in the treatment group rated the following items higher than the traditional group: "I prefer class work that is challenging so I can learn new things", "I prefer course work that makes me curious, even if it is difficult", "I choose assignments I can learn from even if they don't guarantee a good grade", "I am very interested in the lessons in this class", and "I like the subject matter in this class". The results were consistent with other findings that showed students who participated in cooperative learning had more positive attitudes toward learning than students who participated in individualistic learning activities (Johnson & Johnson, 2005; Whicker et al., 1997).

The treatment group's higher scores on the post MSLQ were first evidenced by responses they found learning interesting, enjoyable, and motivating. Johnson and

Johnson (2006) stated that cooperative learning promotes more motivation for students to learn because they are actively involved in an appealing activity. Students in the treatment group were overheard stating that the mathematics activities in class kept their interest because they were having fun working with their peers and enjoyed the activity. The interest level of the activity caused students to be more involved in the learning process. Also, the treatment group's verbal comments on the mathematics activities stated that working in groups was motivating.

Students who were involved in the project-based learning activities reported higher on the item "this class material is useful for me to learn" denoting relevance to them. Johnson and Johnson (2005) reported that the social interdependence theory aspect of cooperative learning results in transfer of learning to a new situation. In cooperative learning activities students are given the opportunity to discuss and collaborate additional ideas of how the content is applicable to them. In this study, students in the treatment group were instructed to identify the theme and the source of the information they presented in their activities. For example, if collecting and interpreting weather data, they would site the place they retrieved their weather information from, in order to construct their chart of data. This aspect of the lesson allowed students to see how the content was relevant to their lives, which increased meaningful learning.

Students who were involved in the treatment group reported putting forth more effort to learn. According to Terenzini (2001), cooperative learning creates positive relationships among students, which in turn produces increased determination in working together to achieve a desired goal. Students reported putting forth more effort into learning because they felt other students were depending on them. The data showed the students' scores for motivation to learn mathematics did drop for both control and treatment groups from the pre to post MSLQ. This drop could be attributed to the fact that the PBLA lessons were no longer a novelty, but instead had become familiar. This idea of familiarity may have slightly decreased motivation at the end of the study, as well as the increase in difficulty of the mathematics content the activities were based upon. Nonetheless, PBLA instructional teaching methods can still be concluded to be a better alternative than traditional instruction teaching methods because the treatment group had a higher recorded motivation than the control group.

Even though the results showed a higher level of motivation in the PBLA group, the data showed that there was no difference in students' achievement. This does not support research in the literature review, where higher levels of motivation from cooperative learning were attributed to higher achievement (Johnson et al., 2013). There was a statistically significant difference in students' motivation of the use of collaborative activities between the control and treatment group. The treatment group had a higher motivation level than the control group. Students in the treatment group rated the following items higher than the control group: "I prefer class work that is challenging so I can learn new things", "I prefer course work that makes me curious, even if it is difficult", "I choose assignments I can learn from even if they don't guarantee a good grade", "I am very interested in the lessons in this class, and I like the subject matter in this class." Students in the treatment group were also overheard as stating that "interacting with classmates makes learning more enjoyable, and I learn better by working in groups." This evidence shows that in the aspect of mathematics teaching methods, students who participated in the treatment group had a more positive attitude and motivation toward mathematics practice than the control group. One reason for these results was the treatment group had more opportunities to participate in engage with peers through the activities because they had to work collaboratively to construct an end result to show skill knowledge each week. Having the chance to experience the benefits of using cooperative learning strategies through hands-on construction of skill application encouraged students to enjoy PBLA more. Battistich, Solomon, and Delucchi (1993) conducted a study that concluded using cooperative learning activities frequently encourages an increase in students' liking of school, higher intrinsic motivation, and self-esteem. Research has shown that when students are motivated it brings about an increase in achievement (Gottfried, 1990). The results of this current study showed that the treatment group had higher motivation toward mathematics than the control group. In addition, research shows that cooperative learning increases motivation compared to traditional instruction (Johnson & Johnson, 2005).

Limitations of the Study

In this study, there were some limitations. One limitation of this study was the sample size of participants (N = 124). The sample size was small because there were only four mathematics classes being taught by this cooperating teacher, at the rural middle school where the study was conducted. A larger sample size might have provided the researcher with more possibilities for deducing more reliable inferences between the two groups.

Another limitation of this study was that the study used a quasi-experimental design with nonequivalent groups, which lacked random sampling. In order to control for this limitation in the future, the researcher would need to use a preliminary *t*-test to look at pretest, included the pretest as covariate, and equate groups on the amount of mathematics students. Due to the lack of random sampling, the generalizability and external validity was limited.

The researcher was also a teacher within the school where this study was conducted. This may have impacted the results because the researcher may have incorporated bias influences into the interpretation of the data and its importance. The researcher was able to observe the students' discussions with other students, and the nonverbal communication among students during the study. This may have allowed the potential of researcher bias to affect data analysis.

An additional limitation of this study was that data for motivation aspect of the study were gathered using self-reports on the instruments. Because of a lack of validity, researchers have disputed the use of self-reported data in a research study. According to Sudman, Bradburn, and Schwarz (1996), minor variations in the wording or formats of questions can strongly influence responses. Also, the participants' interpretation of the question wording and format plays a factor in their response. This study may have provided instruments with questions that the students may not have fully understood or did not know how to respond. This discrepancy of interpretations of the questions among the students may have skewed the results.

Another limitation of this study was the use of different mathematics content for each lesson. This study was conducted during a series of 6 weeks in which 14 different objectives were taught. Each lesson and corresponding activity was presented on a minimum of two different, but synonymous objectives. Because the activities were paired with different objective skill content, making concrete conclusions from the findings was not precise.

The students involved in the study had no previous training on the use of cooperative learning groups before the study began, which is another limitation. The discrepancy of this lack of student training may have been a confounding variable. One other limitation was the attrition of participants throughout the study. Some participants had excessive absences from school or just in this class during the study, which indicated that they may not have participated in the pretest, activities, lessons, evaluations, or posttest. The loss of data from those participants may have affected the validity of the results but the findings did not show differential absences between groups.

A final limitation of this study was that it was strictly quantitative due to limits by the school system against using mixed methods research design without extensive formal proceedings and approvals. It was preferred to use mixed methods research design, to be able to use both quantitative and qualitative data collection methods and analyses to determine the effects of the use of project-based learning activities on students' achievement and motivation. The use of a mixed method research design would provide the researcher with a supplementary research method to outweigh the weaknesses of using solely a quantitative research method. Also, the use of a mixed method design would provide the researcher with an opportunity to unite findings from various data collection methods in order to provide more compelling evidence for a conclusion.

Strengths of the Study

This study had several strengths that increased the validity of the inferences and interpretation of results. A major strength of this study was the use of systematic matching. The study lacked random assignment so systematic matching was used to compensate for the lack of random assignment. Systematic matching provided comparatively equivalent groups that lessened the threats associated with nonrandom assignments.

The second strength of this study was the use of instructional guides such as lesson plans and student group practice organizers within the lesson plans. The instructional guides were used in correlation to the lesson plans, to control for experimental effects by standardizing the content, activities, and assessments. Instructional guides were created for teachers and students, in order to make the procedures of the study as consistent as possible among groups and participants. The extent to which the instructional guides were followed was measured using the Fidelity of Implementation Form.

The third strength of this study was the ideological beliefs of the mathematics teacher. The teacher had a positive outlook on cooperative learning groups and their benefits for her classroom. The teacher was open-minded to the area of need within the mathematics classroom in relation to student achievement and motivation, and accepting to the concept that project-based learning instruction could help bridge those educational gaps. The teacher also expressed interest in future professional development in the area of project-based learning and cooperative learning, to continue these practices with the classroom beyond this study.

The final strength of this study was that all instruments were reviewed, evaluated, and revised by a team of middle school mathematics teachers. The team of mathematics teachers reviewed all instruments to ensure content validity of questions, clarity of question wording, sequencing of questions, and alignment in the activities with mathematics objectives.

Implications for Instructional Design

An instructional designer's objective is to design the most effective instruction based on the needs of the learners and goals of the instruction. This study provided valuable evidence into the field of research that PBLA increased motivation and enjoyment, but not achievement compared to traditional instruction. Also, students involved in PBLA instruction preferred using cooperative learning group activities to demonstrate their ability in the taught skill objective. These implications are synonymous for instructional designers and classroom educators when designing instruction.

Instructional designers and classroom educators should largely incorporate PBLA into the classroom due to its active, hands-on approach to problem solving. Currently there is a major shift in mathematics education toward student-centered, performance-based instruction where students are actively involved and collaborating with other students. This major shift focuses on incorporating learning activities that involve these skills. One way to implement this focus is for instructional designers and classroom educators to integrate student-led, project-based learning instruction into the classroom.

Project-based learning instruction has the possibility of increasing students' attitude, motivation, and enjoyment during instruction. First, students' positive attitudes are determined by how students view subjects. Many students do not have positive attitudes toward mathematics instruction because of its complexity. Project-based instruction creates positive peer relationships among students by supporting positive interdependence and development of social skills. The effects of developing positive peer relationships during project-based learning instruction is more likely to cultivate students' attitude more positively toward learning in general.

Project-based learning that is predominately student-led increases motivation (Johnson & Johnson, 2009). During project-based learning instruction, students are engaged and involved in activities where they are held accountable for their role in the attaining the shared goal of the group. This interdependence encourages intrinsic motivation in mathematics because students see their contribution to the group as a vital component to the success of the group. Extrinsic motivation in mathematics is developed when students participate in a novel, interesting activity, such as mathematics projects, during instruction. These PBLA are interesting to the students and captivated their attention. In addition, instructional guides such as student group organizers activate prior knowledge so that instructional designers or classroom educators can adapt and create instruction toward what students already know, which can spark interest and promote meaningful learning. If students use innovative instructional strategies that make the content meaningful and encourage them to be actively involved in the learning process, the strategy will stimulate the students' interest, subsequently increasing motivation (Mitchell, 1993). In addition, this information from students' prior knowledge can be used to increase the rate of transfer after learning the content. According to Schmidt (1982) prior knowledge activation has facilitative effects on learning and transfer.

Project-based learning instruction increases students' enjoyment. Students who are actively involved in their own learning tend to have higher enjoyment levels. Students become so immersed in the learning activity, they do not recognize it as learning but rather as fun. As a result, incidental learning occurs because students participate in project-based instruction with the intent to enjoy working with their friends in addition to learning. However, learning is a positive side effect of the enjoyable learning activity. When planning instruction, it is important for instructional designers and classroom educators to incorporate instructional strategies that students find enjoyable as well as educational.

From this study, it can be deduced that students involved in project-based learning lessons preferred the cooperative group activities as a form of mathematics practice. These activities could be used to assess and to address students' learning preferences, which in turn may increase motivation. It is important students know how to effectively participate in cooperative learning groups, and project-based learning instruction. This involves the students being properly trained in social, communication, and interpersonal skills to enjoy learning.

In order for project-based learning instruction to be effective, the teacher must have a positive attitude toward cooperative learning. The ideological beliefs about cooperative learning should include support for students' personal and social development and foster achieving higher academic goals for students. Classroom educators need support through professional development on methods to create a successful, cooperative learning classroom.

Recommendations for Future Research

The use of PBLA in a mathematics classroom to increase students' achievement and motivation deserves further study. Other areas of research could provide a new outlook on the effectiveness of project-based learning activities under various conditions. The recommendations for future research include using various educational settings, analyzing gender differences, providing longer implementation periods, and allowing students to construct their own projects.

In the present study, only middle school mathematics students were used as participants in the study. In future research it is recommended that various educational settings be used. This would include a variety of subject areas, ages of students, instructional media, and ability levels to observe differences among educational settings.

This study only looked at students' achievement and motivation in general terms without consideration of gender or race. Weinburgh (1995) reported in a meta-analysis that males, who were especially low and medium-achieving students, have gender differences in attitudes and achievements in mathematics and science. Future research could look at gender differences with advance organizers in regard to students' achievements and attitudes.

Project-based learning activities used in this study were implemented for one academic quarter, which lasted only 9 weeks, 8 of which for the study, as the last week is blocked off for required testing. Future research could investigate the use of project-based learning instruction in longitudinal studies. If students used the PBLA for a longer period of time, it could possibly lead to an increase in students' achievement and motivation, because of more exposure to the project-based learning instructional teaching method.

Research has shown that students benefit when they are expected to build their own techniques and strategies for comparing and contrasting (Chen, Yanowitz, & Daehler, 1996). When students construct their own projects they are given the opportunity to recognize their own schema, determine the best way to integrate new information in their existing schema, increase their motivation through perceived ownership of learning, and facilitate meaningful learning. A follow-up to this study could be that students are given the opportunity to create their own projects to display during the study in order to examine the achievement and motivation between pre-determined PBLA and student-generated PBLA.

The research area of project-based learning can have a substantial impact on students' achievement and motivation. For this reason, future research is warranted to increase empirical data and educational implications of project-based learning instruction. To summarize, the suggestions for future research presented in this study include using various educational settings, analyzing gender differences, providing longer implementation periods, and allowing students to construct their own activities to show skill mastery.

Chapter Summary

This chapter presented a discussion of the results of the current research study. While there were no statistically significant differences between the PBLA and the traditional groups on their posttest scores, there was significance in regard to students' attitude and motivation related to mathematics and participating in cooperative learning activities. Students in the PBLA group had higher mathematics motivation for these categories as measured by the MSLQ, than students in the traditional group. It can be concluded from the data that PBLA are a better alternative to learning than traditional instruction teaching methods because students are more engaged, have higher motivation, and become active learners.

An examination of this study's limitations revealed that using a larger sample size may have allowed the researcher to deduce more reliable inferences. Also, the researcher was one of the teachers in the school where the study was conducted, which may have contributed to researcher bias. Other limitations included attrition of students and the research design based upon county restrictions.

The study's strengths included the use of systematic matching, instructional guides, positive ideological beliefs of cooperative teacher, and an evaluation of instruments by a team of science teachers. Additional research could be conducted in the areas of project-based learning instruction, other kinds of PBLA, and student-generated activities. Many studies have revealed that implementing cooperative learning into learning experiences can increase academic achievement (Johnson & Johnson, 2006; Whicker et al., 1997) and motivation (Johnson & Johnson, 2006; Terenzini, 2001; Whicker et al., 1997).

Many of these studies evaluated the effectiveness of cooperative learning versus traditional classrooms, but few specifically looked at cooperative learning with the use of an instructional strategy such as project-based learning activities within a mathematics classroom. This study contributed to the literature by showing that PBLA can increase student motivation and enjoyment toward mathematics. This study could perhaps inspire more investigation in the area of project-based learning instruction while providing instructional designers and classroom educators with an activity to increase students' motivation.

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Appendices

Appendix A

Motivated Strategies for Learning Questionnaire (MSLQ)
8th Grade

Please rate the following items based on your behavior in this class. Your rating should be on a 7-point scale where 1 = not at all true of me to 7 very true of me. If the statement is not at all true of you, circle 1. If the statement is more or less true of you, find and circle a number between 1 and 7 that best describes you. If the statement is very true of you, circle 7. (Pintrich, Smith, Garcia, & McKeachie, 1991).

1. I prefer class work that is challenging so I can learn new things.
not true 1 2 3 4 5 6 7 very true

2. I prefer course work that makes me curious, even if it is difficult.
not true 1 2 3 4 5 6 7 very true

3. The most important thing for me is trying to understand the lessons in this class.
not true 1 2 3 4 5 6 7 very true

4. I choose assignments that I can learn from even if they don't guarantee a good grade.
not true 1 2 3 4 5 6 7 very true

5. I think I will be able to use what I learn in this class in other classes.
not true 1 2 3 4 5 6 7 very true

6. It is important for me to learn the material in this class.
not true 1 2 3 4 5 6 7 very true

7. I am very interested in the lessons in this class.
not true 1 2 3 4 5 6 7 very true

8. This class material is useful for me to learn.
not true 1 2 3 4 5 6 7 very true

9. I like the subject matter in this class.
not true 1 2 3 4 5 6 7 very true

10. Understanding the subject matter of this class is very important to me.
not true 1 2 3 4 5 6 7 very true

11. I believe I will receive an excellent grade in this class.
not true 1 2 3 4 5 6 7 very true

12. I'm certain I can understand the most difficult material presented in the reading for this class.

not true **1** **2** **3** **4** **5** **6** **7** **very true**

13. I'm confident I can learn the basic lessons in this class.

not true **1** **2** **3** **4** **5** **6** **7** **very true**

14. I am confident I can understand the most complex material presented by the teacher.

not true **1** **2** **3** **4** **5** **6** **7** **very true**

15. I am confident I can do an excellent job on the assignments and tests in this class.

not true **1** **2** **3** **4** **5** **6** **7** **very true**

16. I expect to do well in this class.

not true **1** **2** **3** **4** **5** **6** **7** **very true**

17. I'm certain I can master the skills being taught in this class.

not true **1** **2** **3** **4** **5** **6** **7** **very true**

18. Considering the difficulty of this class, the teacher, and my skills, I think I will do well in this class.

not true **1** **2** **3** **4** **5** **6** **7** **very true**

Appendix B

Pre-and Post-Test

Student ___________________Class __________________

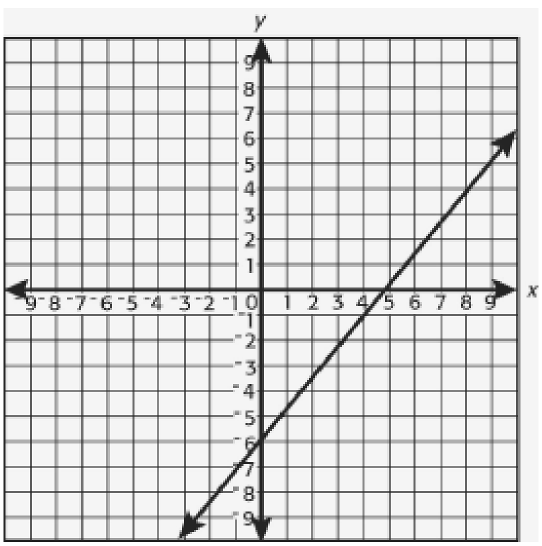
____1. Order the numbers from least to greatest.

0.447, 0.53, ½

A. ½, 0.447, 0.53 B. 0.53, 0.447, ½

C. 0.447, ½, 0.53 D. 0.53, ½, 0.447

____2. Which correctly lists the slope and the y-intercept of the line graphed below?



A $m = 4/5$ **C** $m = 5/4$

b = -6 b = -6

B $m = 5/4$ **D** $m = 4/5$

b = 5 b = 5

____3. If you are making 22 hamburgers and 4 burgers come in each package, how many packages will you need to buy?

A. 6 packages B. 5.5 packages C. 7.48 packages D. 7 packages

__4. A rare comic book costs $20.76. If 6 fans split the cost equally, how much will each pay?

A. $34.60 B. $0.35 C. $3.46 D. $14.76

_____5. Three bricks have the following weights: 3.16 pounds, 2.89 pounds, and 2.81 pounds. Determine their approximate total weight.

A. 6 B. 8.86 C. 10 D. 9

_____6. Four artichokes have the following weights: 11.84 grams, 12.06 grams, 12.16 grams, and 11.91 grams. Use clustering to determine their approximate total weight.

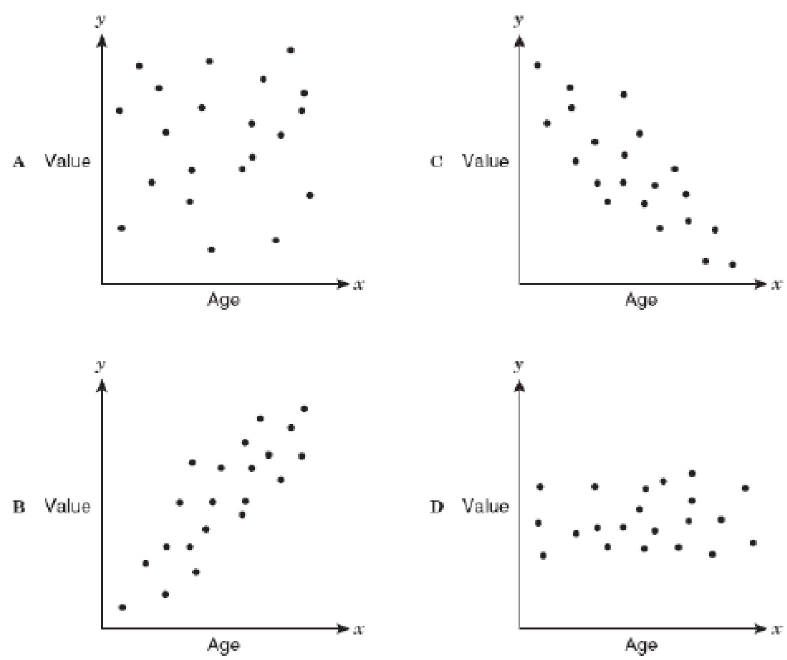
A. 48 B. 50 C. 47.97 D. 36

_____7. Perform the following calculation: 15.19 x 100.

A. 15, 190 B. 1,519 C. 151.9 D. 0.1519

_____8.

'. **As the age of a car increases, its value decreases. Which scatterplot best represents this relationship?**



____9. Find the range, mean, median, and mode of the following data set. (5, 17, 21, 21, 7, 13, 1, 3)

A. Range 20
Mean 10
Median 10
Mode 21

C. Range 20
Mean 11
Median 10
Mode 21

B. Range 20
Mean 11
Median 21
Mode 21

D. Range 24
Mean 11
Median 10
Mode 5

10.

Use the two-way table to determine the relative frequency of students who play a sport and like football to the total number of students plays a sport. Round to the nearest hundredth.

	Likes football	Dislikes football
Plays a sport	50	10
Does not play a sport	10	30

a. 0.17

b. 0.25

c. 0.75

d. 0.83

Appendix C

Eighth Grade Mathematics Projects

1. **It is Only Natural** (skills: identify two-or three-dimensional shapes, identify types of symmetry as it appear in nature) Working in groups of two or three, students will make a collage by cutting pictures out of magazines or drawing them to illustrate examples of mathematics in nature.

2. **The School's New Lunch Program** (skills: estimating cost, conducting a poll) Working in groups of four or five, students will design a five-day meal plan based on the major food groups.

3. **What is the Weather?** (skills: collecting and interpreting data, expressing information in the forms of graphs, tables, or charts) Working in pairs or groups of three, students will observe and chart various weather conditions-including temperature, wind speed and direction, precipitation, and cloud cover for seven days. At the end of this period, students will organize and represent their observation in graphs, tables, and charts.

4. **A Flight to Mars** (skills: making a model, visualizing spatial relationships) Working in groups of three to five, students will assume that their group is part of the first human flight to Mars. They will decide which items or equipment they would bring, being sure that their material will fit within a 2 feet by 2 feet by 2 feet cubicle. At the end, each group will share their list and explain why they selected the materials they did.

5. **Creating a Scale Map** (skills: making a scale drawing, measuring distance) Working in groups of three, students will create a scale map of their school, school grounds, or yard at the home of one of the group members. They will include landmarks, important

details, legends, and an accurate scale.

6. **Lands of Ethnic Origin** (skills: using mathematics to communicate ideas, analyzing data) Working individually, students will research a country of their ethnic origin and use mathematics to describe it.

7. **Be Your Own Boss** (skills: find the products of decimals and whole numbers) Working individually, students will design a small business to sell a particular product. They will determine the cost of production and the price for which their product will be sold.

8. **Vacation Destination** (skills: round, add, and estimate decimals) Working in groups of three, students will plan a vacation and calculate the total cost including transportation, lodging, food, and tourist attractions.

9. **Hot off the Press** (skills: express fractions and ratios in simplest form) Working individually, students will choose four magazines and use fractions, ratios, and decimals to express the relationship between the different types of pages.

10. **The Wonderful World of Toys** (skills: convert between fractions, decimals, and percents) Working in groups of three, students will use ratios, fractions, and percents to compare the size of toys to the actual size of the objects that they represent.

11. **Designing a Dream House** (skills: determine angles, name two-dimensional figures) Working individually, the students will determine the actual angle measures and wall lengths of a floor plan drawn to scale.

12. **Collect a Fortune** (skills: graph functions from function tables) Working in groups of three to four, students will start a collection and research its history and value. Students will prepare a display showing the collection and research.

13**.** **Here Today, Gone Tomorrow** (skills: find and interpret the probability of an event) Working in groups of four to five, students will use experiments and probability to explore how camouflage works. They will research an animal and relate their statistical findings to how and why this particular animal uses camouflage.

14. **Pets are (Hu)mans' Best Friends** (skills: construct bar graphs, analyze mean, median, mode) Working individually, students will make a presentation using information from those students in the class that have pets.

15. **Shop 'til You Drop** (estimating sums using rounding) Working individually, students will use an assortment of mail-order catalogs and go on a make-believe shopping spree. They will use mental math in order to estimate the total of their shopping spree. They will then check to see how close they are to the real total.

Appendix D

IRB Approval Form

irb@southalabama.edu

UNIVERSITY OF SOUTH ALABAMA

TELEPHONE: (251) 460-6308
CSAB 138 - MOBILE, AL. 36688-0002

INSTITUTIONAL REVIEW BOARD
May 6, 2016

Principal Investigator:	Rachel Mudrich		
IRB # and Title:	IRB PROTOCOL: 16-128 [861721-1] THE EFFECTS OF PROJECT-BASED LEARNING ACTIVITIES ON ACADEMIC ACHIEVEMENT AND MOTIVATION IN MATHEMATICS IN EIGHTH GRADE STUDENTS		
Status:	APPROVED	Review Type:	Expedited Review
Approval Date:	May 3, 2016	Submission Type:	New Project
Initial Approval:	May 3, 2016	Expiration Date:	May 2, 2017
Review Category:	Category: 45 CFR 46.110 (7): Research on individual or group characteristics or behavior		
DHHS/FDA Subpart D:	45 CFR 46.404: FDA 50.51 - Research not involving greater than MINIMAL RISK to children		

This panel, operating under the authority of the DHHS Office for Human Research and Protection, assurance number FWA 00001602, has reviewed the submitted materials for the following:

1. *Protection of the rights and the welfare of human subjects involved.*
2. *The methods used to secure and the appropriateness of informed consent.*
3. *The risk and potential benefits to the subject.*

The regulations require that the investigator not initiate any changes in the research without prior IRB approval, except where necessary to eliminate immediate hazards to the human subjects, and that **all problems involving risks and adverse events be reported to the IRB immediately!**

Subsequent supporting documents that have been approved will be stamped with an IRB approval and expiration date (if applicable) on every page. Copies of the supporting documents must be utilized with the current IRB approval stamp unless consent has been waived.

Notes:

Data collected in manner to not violate FERPA

Appendix E

MCPSS Research Approval

Mobile County
PUBLIC SCHOOLS

1 Magnum Pass | Mobile, Alabama 36618 | 251-221-4000 | www.mcpss.com

March 21, 2016

Rachel M. Mudrich
6965 Walter Tanner Road
Wilmer, AL 36587

Dear Ms. Mudrich,

Thank you for your interest in conducting research with the Mobile County Public School System. We have received your External Research Proposal Request Application, and we are pleased to inform you that your study proposal, *The Effects of Project-Based Learning Activities on Intrinsic Motivation and Academic Achievement in Mathematics in Eighth-Grade Students*, has been accepted.

Your research proposal is subject to the terms and conditions outlined in the External Research Proposal Request Application. Please be reminded that a copy of your Institutional Review Board approval letter must be submitted prior to the implementation of your study.

If you have any questions concerning this research approval, please contact Merrier A. Jackson, Research and Development Specialist at majackson@mcpss.com.

Once again our best regards as you proceed in the implementation of this proposal.

Sincerely,

Susan Hinton

Dr. Susan Hinton, Executive Director
Research, Assessment, Grants, and Accountability

/maj

Appendix F

INFORMED CONSENT
TO PARTICIPATE IN A RESEARCH STUDY
(Principal)

My name is Rachel M. Mudrich. I am a graduate student in the program of Instructional Design and Development at the University of South Alabama in Mobile, Alabama. You are being asked to allow a research study to be conducted at your school. Please read this form and ask any questions that you may have before agreeing to take part in this study.

Purpose of the Research Study

The purpose of this study is to investigate the effects of project-based learning activities on intrinsic motivation and academic achievement of eighth grade middle school math students in the experimental groups. This research will focus on how projects affect the relationships between intrinsic motivation and academic achievement in math. The students that are a part of the control groups will not participate in project-based learning activities. These students will be a part of a traditional teacher led classroom.

Research Questions

1. Do project-based learning activities have an effect on the intrinsic motivation perception for eighth-grade middle school math students?
2. Do project-based learning activities have an effect on the academic achievement in mathematics for eighth-grade middle school students?
3. Do project-based learning activities have an effect on the academic achievement in mathematics for eighth-grade middle school students based on gender?
4. Do project-based learning activities have an effect on the intrinsic motivation perception for eighth-grade middle school students based on gender?

Procedures

If you agree to allow your school to participate in this study, you will be asked to do the following things:

1. Meet with the researcher to discuss the study.
2. Allow the assent and consent forms to be distributed by the researcher to the participating teachers.
3. Allow the participating teachers to periodically meet with the researcher.
4. Meet with the researcher at the end of the study to discuss the findings of the study, if you choose to do so.
5. Allow the researcher to collect the completed pre and post questionnaires, which will be sealed envelope, from each participating teacher. Note: The envelope will not be unsealed by the researcher until after all data has been collected.
6. Allow time for periodically meetings between the researcher and teacher on the progress of the participating students.

If you agree to allow your school to participate in this study, your eighth-grade mathematics teacher will be asked to do the following things:

1. Teacher of both the control and experimental groups will distribute and collect the assent and parental consent forms.
2. Teacher of the experimental groups will include project-based activities in their classrooms two to three times per week. (refer to Appendix C for treatments).
3. Teacher of both the control and experimental groups will distribute the *Motivated Strategies for Learning Questionnaire (MSLQ)* before and at the end the study.
4. Teacher of both control and experimental groups will collect the completed pre- and post-questionnaires in a large envelope to be provided by the researcher. Note: The envelope will not be unsealed by the researcher until all data has been collected.
5. Teachers of the experimental groups will periodically update the researcher on the progress of the participating students.

If you agree to allow your school to participate in this study, the participating students will be asked to do the following things:

1. Take home Parent/Guardian Consent and Student Assent forms to be completed and signed by the student, and the student's parent or guardian.
2. Complete a motivation questionnaire measuring how he or she feels about his or her learning experiences in the classroom.
3. Participate in mathematics projects during class, as part of the instruction they receive.
4. Complete a motivation questionnaire measuring how their feelings may have changed after completing the projects.
5. Participate in interviews, focus groups, and group discussions to express opinions on the study.

Voluntary Nature of the Study

Participation in the research is voluntary. You or the participating teachers, students or their parent(s)/guardian(s) may later decide not to be included in the study. If this becomes the case, the teachers can withdraw from the study and no one will not be penalized or lose any of the benefits to which anyone is otherwise entitled. If you, the teacher, student or his or her parent(s)/guardian(s) decides not to be included in the study after it starts, all information will be withdrawn from the study and destroyed.

Confidentiality

<u>Due to the Open Records Act, confidentiality can only be maintained within the limits allowed by law. In order to ensure strict confidentiality, no participants will be identified by name.</u> The specific records of participants in this study will be kept private. In published reports, there will be no information included that will make it possible to identify the research participant. Research records will be stored securely in a locked cabinet and only participating teachers and the researcher will have access to the records. The participating classroom teacher will code the participating students' names by numbers and their gender will be coded F for female and M for male. Teachers' classrooms will be coded as Class 1 and Class 2 and the schools will be coded as School A, School B, and School C. For example one student's coding may be as follows: School

A, Class 2, Fl. All coded information will be sealed in an envelope by the participating teacher and given directly to the researcher. Any information stored on the researcher's computer will be password protected. If you withdraw your school from the study after it has begun, your information will be deleted. At the conclusion of the study, all data will be shredded.

Contacts and Questions:
You are encouraged to contact the researcher or the researcher's dissertation chair if you have any questions. You may contact me at 251-599-4085 or rachelmudrich@gmail.com. You may also write me at my mailing address: PO Box 635 Wilmer, AL 36587. My research dissertation chair is Dr. Brenda Litchfield. She can be contacted at 251-380-2861. Her email is bcl@southalabama.edu. If you have any questions about your rights as a research participant, you may contact the University of South Alabama - Institutional Review Board Office at 251-460-6625 or dlayton@southalabama.edu.

You will be given a copy of this information to keep for your records. If you are not given a copy of this consent form, please request one.

STATEMENT OF CONSENT
I have read the above information. I have had the opportunity to ask questions and have received satisfactory answers. I consent to participate in the study.

_______________________________________ ____________________________

Name of Principal (Please Print) Date

_______________________________________ ____________________________

Signature of Principal Date

_______________________________________ ____________________________

Signature of Researcher Date

Appendix G

ASSENT TO PARTICIPATE IN A STUDY
(PARENT/GUARDIAN/STUDENT)

My name is Rachel M. Mudrich. I am a graduate student in the program of Instructional Design and Development at the University of South Alabama in Mobile, Alabama. You are being asked to volunteer for a research study.

These are some things we want you to know about research studies:
I am asking you to be in a research study. Research is a way to test new ideas. Research helps us learn new things. In my research study, I am trying to learn more about how hands-on, performance based projects may affect how eighth-grade math students succeed academically and how they feel about math.

This is what you will be asked to do:
If you agree to participate in the study, you may or may not be asked to participate in these educational projects with other students in your class. Some students will participate in projects with their classmates as part of this study, while other classes of students will not participate in these projects. Whether or not you want your information included in the study is up to you and your parent(s)/guardian(s). You can say Yes or No. If your parent(s)/guardian(s) say "Yes" and you do not want to be in the study, then your information will not be included. If you want to be a part of the study, but your parent(s)/guardian(s) does not want you to, then your information will not be included.

What if I don't want to be in this study?
Participating in the study is voluntary. This means that you get to choose if you want to be a part of the study. Although students will participate in the activities, you may decide not to include your information in the study. If you choose not to participate, your information will not be included in the study and you will not be penalized or lose any points. If you participate and your parent(s)/guardian(s) change his or her minds later, your information will be destroyed and will not be included in the study. Please talk this over with your parent(s)/guardian(s) and decide whether you want to be a part of the study, and if they want for you to take part in this study.

Will anybody else know what I say or write down?
All of your records about this research study will be kept locked up so no one except the researcher can see them. The researcher will also keep your information on his computer and only she will have the password. All of your records will be destroyed after the study is over. If you decide to stop being in the study, your records will also be destroyed. At the conclusion of the study, all of the information will be shredded.

Who should I ask if I have any questions?
You are encouraged to contact the researcher or the researcher's dissertation chair if you have any questions. You may contact me at 251-599-4085 or

rmm1002@jagmail.southalabama.edu. My research dissertation chair is Dr. Brenda Litchfield. She can be can be contacted at 251-380-2861 or via email at bcl@southalabama.edu. If you have any questions about your rights as a research participant, you may contact the University of South Alabama - Institutional Review Board Office at 251-460-6625 or dlayton@southalabama.edu.

Agreement to be in the research study:
Now that I have asked my questions and think I know about the study and what it means, here is what I have decided:

___ OK, I will be in the study.   ___ No, I do not want to be in the study

You will be given a copy of this information to keep for your records. If you are not given a copy of this consent form, please request one.

STATEMENT OF CONSENT

I have read the above information. I have had the opportunity to ask questions and have received satisfactory answers. I understand that my child will participate in the activities during this study, but I may opt out on his or her information being included in the study. If I opt out, my child's information will not be included in the study and he or she will not be penalized.

I consent to allow my child's information to be used in this study.

Name of Parent/Guardian (Please Print)	Date
Signature of Parent/Guardian	Date
Name of Participant (Please Print)	Date
Signature of Participant	Date
Signature of Researcher	Date

Appendix H

Mathematics Pacing Guide

MOBILE COUNTY PUBLIC SCHOOLS
DIVISION OF CURRICULUM & INSTRUCTION
MIDDLE SCHOOL PACING GUIDE AT A GLANCE
FALL SEMESTER 2015-2016
Mathematics 8

A L C O S	Resource Materials Website Lesson/Activities All tasks are located on Curriculum CD	WEEK	Standards/Objectives First Quarter Fluency Standards – Add, subtract, multiply, and divide rational numbers.	Dates: Taught	Tested
1 2 3 4	**HCPSS Tasks:** *"Discovering Rational and Irrational Numbers"* 8.NS1 *"The Code Name Organizer"* 8.NS2 **Engage NY Task:** *"Lesson 6: Finite and Infinite Decimals"* **CCSS Tasks:** *"Real Number Race"* 8-NS1 *"The Laundry Problems"* 8-NS1 **CCGPS Task:** *Unit 2(Exponent): "Rational or Irrational Reasoning?" pg.10-12* 8-NS2 **Engage NY Lessons:** *"Lesson 11: The Decimal Expansion of Some Irrational Numbers"* *"Lesson 1: Exponential Notation"* *"Lesson 2: Multiplication of Numbers in Exponential Form"* **HCPSS Tasks:** *"Expressions with Zero and Negative Exponents"* 8.EE1-2 *"Cube Hotel"* 8.EE2 **MARS. Shell Center Task:** *"100 People"*	Weeks 1 - 3 Aug 10-28	**Habits of Success Task** **Review Summer Math Packet** ***UNIT 1*** ***(Rational and Irrational Numbers)*** • Know that numbers that are not rational are irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually, and convert a decimal expansion which repeats eventually into a rational number. [8-NS1] *Lessons 1-1 and 1-10* • Use rational approximations or irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions. [8-NS2] *Lessons 1-9 and 1-10* ***UNIT 2*** ***(Integers with Exponents)*** **Review Integer Rules** • Know and apply the properties of integer exponents to generate equivalent numerical expressions. [8-EE1] *Lessons 1-2, 1-3, 1-4, and 1-5* • Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational. [8-EE2] *Lesson 1-8*		

MOBILE COUNTY PUBLIC SCHOOLS
DIVISION OF CURRICULUM & INSTRUCTION
MIDDLE SCHOOL PACING GUIDE AT A GLANCE
FALL SEMESTER 2015-2016
<u>Mathematics 8</u>

ALCOS	Resource Materials Website Lesson/Activities **All tasks are located on Curriculum CD**	WEEK	**Standards/Objectives** First Quarter **Fluency Standards – Add, subtract, multiply, and divide rational numbers.**	Dates: Taught	Dates: Tested
5 6 16 19 17 18	**MARS (FAL):** **Estimating Length Using Scientific Notation** **HCPSS Tasks:** *"Intro to Scientific Notation"* **8.EE3** *"Scientific Notation Word Problems"* **8.EE3** *"Scientific Notation Exit Ticket"* **8.EE3** **MARS. Shell Center:** *" Estimating Length Using Scientific Notation"* **Engage NY Lessons:** *Lesson 9: Scientific Notation* *Lesson 11: Efficacy of the Scientific Notation* **HCPSS 8.G1-4 Task:** *"8.G.3 Transformation Exploration"* *"Graphic Art Contest"* **Engage NY Tasks:** *"Lesson 1: What Lies Behind "Same Shape"?"* **MARS. Shell Center Tasks:** *"Representing and Combining Transformations"*	**Weeks 4 – 6** Aug 31 – Sept. 18 **LABOR DAY** Sept. 11	*UNIT 3 (Scientific Notations)* • Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. [8-EE3] • Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology. [8-EE4] **Lessons 1-6 and 1-7** STEM PROJECT # 1 *" Galvanized Batteries"* *UNIT 4 (Transformations)* ***Review Coordinate Plane*** • Verify experimentally the properties of rotations, reflections, and translations: **[8-G1]** ***Lesson:*** *IQL 6-1, 6-1, 6-2, IQL6-3, 6-3, 7-1* a. Lines are taken to lines, and line segments are taken to line segments of the same length. **[8-G1a]** ***Lesson:*** *IQL 6-1,7-1* b. Angles are taken to angles of the same measure. **[8-G1b]**. **Lesson:** *IQL 6-1,7-1* c. Parallel lines are taken to parallel lines. **[8-G1c]** ***Lesson:*** *IQL 6-1* • Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them. **[8-G4]** ***Lessons:*** *IQL 6-4,7-3,7-4* • Understand that two-dimensional figure is similar to another if the second can be obtained fro m the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.**[8-G2]** ***Lessons:*** *IQL 7-1,7-1,IQL 7-2,7-2* • Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates. **[8-G3]** ***Lessons:*** 6-1, 6-2, 6-3, 6-4		

MOBILE COUNTY PUBLIC SCHOOLS
DIVISION OF CURRICULUM & INSTRUCTION
MIDDLE SCHOOL PACING GUIDE AT A GLANCE
FALL SEMESTER 2015-2016
Mathematics 8

ALCOS	Resource Materials Website Lesson/Activities All tasks are located on Curriculum CD	WEEK	Standards/Objectives First Quarter Fluency Standards – Add, subtract, multiply, and divide rational numbers.	Dates: Taught	Dates: Tested
25 26 28	**MARS (FAL)** **Representing and Combining Transformations** **Engage NY Lessons:** *"Lesson 6: Scatter Plots"* *"Lesson 7: Patterns in Scatter Plots"* *"Lesson 13: Summarizing Bivariate Categorical Data in a Two-Way Table"* **HCPSS Tasks:** *"What is the Relationship"* 8.SP1 *"Using and Interpreting Linear Models"- Project* 8.SP3	**Weeks 7 – 9** Sept. 21 – Oct. 8 **EQTs** **October 5 – 8**	***UNIT 5*** ***(Bivariate Statistics)*** • Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association. [8-SP1] ***Lessons:*** *IQI.9-1, 9-1, 9-2, IQI.9-2* • Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally assess the model fit by judging the closeness of the data points to the line. [8-SP2] ***Lessons:*** *IQI.9-2,9-2* • Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. [8-SP4] ***Lesson:*** *9-3* **EQT Testing** **End of Quarter 1**		

Appendix I

Weekly Lesson Plans

Week 1

Skills: 8-G1/AL16; 8-G2/AL17; 8-G4/AL19; 8-G5/AL20

Lesson: Geometry and Angles **Participants:** Whole Class/Both Groups

Time Required: 25 minutes

Goal of Activity: To activate students' prior knowledge on the concepts of geometry and angles in order to identify misconceptions and preconceived ideas and address them before applying the content.
Phase of Cycle of Instruction: Introduction and Guided Practice

Cycle of Instruction:	
Introduction	Class will be given a bell ringer problem that will require them to active prior knowledge to solve and explain.
	Teacher will use bell ringer problem to transition into the lesson on geometry and angles. Teacher will review rotations, reflections, translations of 2D and 3D figures, types of 2D and 3D figures, and the angles involved in all geometrical figures. This will be done on whiteboard/SMARTboard via teacher made example problems.
(15 minutes)	Students will view examples, discuss and explain the process as a whole group, record findings into notes for future reference.
	All groups will remain in whole group for guided practice
Guided **Practice** (10 minutes)	After the lecture, the teacher will create examples on the whiteboard/SMARTboard for students to work individually on in order to apply the skills taught. The teacher will rotate throughout the room, answering questions, and affirming students on their findings.
Treatment groups will move into PBLA groups at this point for independent practice	
Control groups will work on individual problem sets given by teacher for independent practice	

Student Independent Practice
Week 1 – Geometry and Angles

Group Moderator____
Group Recorder____
Group Summarizer/Timekeeper______________________________________

Phase of Cycle of Instruction: Independent Practice

Introduction 	The purpose of this activity is to activate your prior knowledge on the concept of geometry and angles in order to show application of this knowledge through the completion of a project-based learning activity of your choice dealing with these skills. For this activity you will use the 8^{th} Grade Mathematics Projects list to select a project to complete to show your knowledge base on these skills.

Time	Activity	Comments
2 mins	Each group will receive a group list of the 8^{th} Grade mathematics projects. Group moderator will display list for group to see options.	Moderator, recorder, summarizer job will rotate weekly throughout the group. All will hold each roll eventually.
3 mins	The project choices for this week that deal with this skills set are projects #1 and #11. Group moderator will use the round table strategy and call on members to voice their project selection choice. Recorder will tally votes, most votes will be the group project for this week. (In the event of a tie, moderators vote is the tie breaker).	
25 mins	After project is selected, students will work daily on the group projects during independent practice time. Groups will be responsible for gathering needed materials to complete their projects. If any additional items are needed, groups must notify teacher by end of the first day of the week for teacher to get supplies for next class day.	
5 mins	The group summarizer will vocalize what the group has learned that day with the rest of the group, and record it in math journal for this study and class. Project group summaries will be shared with rest of the class during open discussion time in the last week of the quarter.	

Weekly Lesson Plans

Week 2

Skills: 8-G6/AL21; 8-G7/AL22; 8-G8/AL23

Lesson: Pythagorean Theorem **Participants:** Whole Class/Both Groups

Time Required: 25 minutes

Goal of Activity: To activate students' prior knowledge on the concept of the Pythagorean Theorem in order to identify misconceptions and preconceived ideas and address them before applying the content.
Phase of Cycle of Instruction: Introduction and Guided Practice

Cycle of Instruction:	
Introduction	Class will be given a bell ringer problem that will require them to active prior knowledge to solve and explain.
	Teacher will use bell ringer problem to transition into the lesson on the Pythagorean Theorem. Teacher will review the formula, types of triangles, scale models, and scale drawings using the Pythagorean Theorem as the basis. This will be done on whiteboard/SMARTboard via teacher made example problems.
	Students will view examples, discuss and explain the process as a whole group, record findings into notes for future reference.
	All groups will remain in whole group for guided practice.
Guided Practice	After the lecture, the teacher will create examples on the whiteboard/SMARTboard for students to work individually on in order to apply the skills taught. The teacher will rotate throughout the room, answering questions, and affirming students on their findings.
Treatment groups will move into PBLA groups at this point for independent practice	
Control groups will work on individual problem sets given by teacher for independent practice	

Student Independent Practice
Week 2 – Pythagorean Theorem

Group Moderator____
Group Recorder____
Group Summarizer/Timekeeper____

Phase of Cycle of Instruction: Independent Practice

Introduction 	The purpose of this activity is to activate your prior knowledge on the concept of the Pythagorean Theorem in order to show application of this knowledge through the completion of a project-based learning activity of your choice dealing with these skills. For this activity you will use the 8^{th} Grade Mathematics Projects list to select a project to complete to show your knowledge base on these skills.

Time	**Activity**	**Comments**
2 mins	Each group will receive a group list of the 8^{th} Grade mathematics projects. Group moderator will display list for group to see options.	Moderator, recorder, summarizer job will rotate weekly throughout the group. All will hold each roll eventually.
3 mins	The project choices for this week that deal with this skills set are projects #4 and #5. Group moderator will use the round table strategy and call on members to voice their project selection choice. Recorder will tally votes, most votes will be the group project for this week. (In the event of a tie, moderators vote is the tie breaker).	
25 mins	After project is selected, students will work daily on the group projects during independent practice time. Groups will be responsible for gathering needed materials to complete their projects. If any additional items are needed, groups must notify teacher by end of the first day of the week for teacher to get supplies for next class day.	
5 mins	The group summarizer will vocalize what the group has learned that day with the rest of the group, and record it in math journal for this study and class. Project group summaries will be shared with rest of the class during open discussion time in the last week of the quarter.	

Weekly Lesson Plans

Week 3

Skills: 8-NS1/AL1; 8-NS2/AL2

Lesson: Number Sense and Conversions **Participants:** Whole Class/Both Groups

Time Required: 25 minutes

Goal of Activity: To activate students' prior knowledge on the concepts of number sense and conversions in order to identify misconceptions and preconceived ideas and address them before applying the content.

Phase of Cycle of Instruction: Introduction and Guided Practice

Cycle of Instruction:	
Introduction	Class will be given a bell ringer problem that will require them to active prior knowledge to solve and explain.
	Teacher will use bell ringer problem to transition into the lesson on number sense and conversions. Teacher will review rational and irrational numbers, and conversions between fractions, decimals, and percents. This will be done on whiteboard/SMARTboard via teacher made example problems.
	Students will view examples, discuss and explain the process as a whole group, record findings into notes for future reference.
	All groups will remain in whole group for guided practice
Guided Practice	After the lecture, the teacher will create examples on the whiteboard/SMARTboard for students to work individually on in order to apply the skills taught. The teacher will rotate throughout the room, answering questions, and affirming students on their findings.
Treatment groups will move into PBLA groups at this point for independent practice	
Control groups will work on individual problem sets given by teacher for independent practice	

Student Independent Practice
Week 3 – Number Sense and Conversions

Group Moderator____
Group Recorder____
Group Summarizer/Timekeeper____

Phase of Cycle of Instruction: Independent Practice

Introduction	
	The purpose of this activity is to activate your prior knowledge on the concepts of number sense and conversions in order to show application of this knowledge through the completion of a project-based learning activity of your choice dealing with these skills. For this activity you will use the 8th Grade Mathematics Projects list to select a project to complete to show your knowledge base on these skills.

Time	**Activity**	**Comments**
2 mins	Each group will receive a group list of the 8th Grade mathematics projects. Group moderator will display list for group to see options. *(This will be a 2 week lesson, due to the number of projects these skills cover. Groups will select 2 projects, one per week).	Moderator, recorder, summarizer job will rotate weekly throughout the group. All will hold each roll eventually.
3 mins	The project choices for this week that deal with this skills set are projects #7, #8, #9, #10 and #15. Group moderator will use the round table strategy and call on members to voice their project selection choice. Recorder will tally votes, top two with the most votes will be the group project for this week. (In the event of a tie, moderators vote is the tie breaker).	Two projects, one per week (weeks 3 and 4).
25 mins	After projects are selected, students will work daily on the group projects during independent practice time. Groups will be responsible for gathering needed materials to complete their projects. If any additional items are needed, groups must notify teacher by end of the first day of the week for teacher to get supplies for next class day.	
5 mins	The group summarizer will vocalize what the group has learned that day with the rest of the group, and record it in math journal for this study and class. Project group summaries will be shared with rest of the class during open discussion time in the last week of the quarter.	

Weekly Lesson Plans

Week 4 (Continuation of Week 3)

Skills: 8-NS1/AL1; 8-NS2/AL2

Lesson: Number Sense and Conversions **Participants:** Whole Class/Both Groups

Time Required: 25 minutes

Goal of Activity: To activate students' prior knowledge on the concepts of number sense and conversions in order to identify misconceptions and preconceived ideas and address them before applying the content.
Phase of Cycle of Instruction: Introduction and Guided Practice

Cycle of Instruction:	
Introduction	Class will be given a bell ringer problem that will require them to active prior knowledge to solve and explain.
	Teacher will use bell ringer problem to transition into the lesson on number sense and conversions. Teacher will review rational and irrational numbers, and conversions between fractions, decimals, and percents. This will be done on whiteboard/SMARTboard via teacher made example problems.
	Students will view examples, discuss and explain the process as a whole group, record findings into notes for future reference.
	All groups will remain in whole group for guided practice
Guided Practice	After the lecture, the teacher will create examples on the whiteboard/SMARTboard for students to work individually on in order to apply the skills taught. The teacher will rotate throughout the room, answering questions, and affirming students on their findings.
Treatment groups will move into PBLA groups at this point for independent practice	
Control groups will work on individual problem sets given by teacher for independent practice	

Student Independent Practice
Week 4 – Number Sense and Conversions

Group Moderator____
Group Recorder____
Group Summarizer/Timekeeper____

Phase of Cycle of Instruction: Independent Practice

Introduction 	The purpose of this activity is to activate your prior knowledge on the concepts of number sense and conversions in order to show application of this knowledge through the completion of a project-based learning activity of your choice dealing with these skills. For this activity you will use the 8^{th} Grade Mathematics Projects list to select a project to complete to show your knowledge base on these skills.

Time	Activity	Comments
2 mins	Each group will receive a group list of the 8^{th} Grade mathematics projects. Group moderator will display list for group to see options. *(This will be a 2 week lesson, due to the number of projects these skills cover. Groups will select 2 projects, one per week).	Moderator, recorder, summarizer job will rotate weekly throughout the group. All will hold each roll eventually.
3 mins	The project choices for this week that deal with this skills set are projects #7, #8, #9, #10 and #15. Group moderator will use the round table strategy and call on members to voice their project selection choice. Recorder will tally votes, top two with the most votes will be the group project for this week. (In the event of a tie, moderators vote is the tie breaker).	Two projects, one per week (weeks 3 and 4).
25 mins	After projects are selected, students will work daily on the group projects during independent practice time. Groups will be responsible for gathering needed materials to complete their projects. If any additional items are needed, groups must notify teacher by end of the first day of the week for teacher to get supplies for next class day.	
5 mins	The group summarizer will vocalize what the group has learned that day with the rest of the group, and record it in math journal for this study and class. Project group summaries will be shared with rest of the class during open discussion time in the last week of the quarter.	

Weekly Lesson Plans

Week 5

Skills: 8-SP1/AL25; 8-SP4/AL28

Lesson: Graphing and Analyzing Data **Participants:** Whole Class/Both Groups

Time Required: 25 minutes

Goal of Activity: To activate students' prior knowledge on the concepts of graphing and analyzing data in order to identify misconceptions and preconceived ideas and address them before applying the content.

Phase of Cycle of Instruction: Introduction and Guided Practice

Cycle of Instruction:	
Introduction	Class will be given a bell ringer problem that will require them to active prior knowledge to solve and explain.
	Teacher will use bell ringer problem to transition into the lesson on graphing and analyzing data. Teacher will review types of graphs, how to record data onto graphs, and how to analyze data from types of graphs. This will be done on whiteboard/SMARTboard via teacher made example problems.
	Students will view examples, discuss and explain the process as a whole group, record findings into notes for future reference.
	All groups will remain in whole group for guided practice
Guided Practice	After the lecture, the teacher will create examples on the whiteboard/SMARTboard for students to work individually on in order to apply the skills taught. The teacher will rotate throughout the room, answering questions, and affirming students on their findings.
Treatment groups will move into PBLA groups at this point for independent practice	
Control groups will work on individual problem sets given by teacher for independent practice	

Student Independent Practice
Week 5 – Graphing and Analyzing Data

Group Moderator____
Group Recorder____
Group Summarizer/Timekeeper_______________________________________

Phase of Cycle of Instruction: Independent Practice

Introduction 	The purpose of this activity is to activate your prior knowledge on the concepts of graphing and analyzing data in order to show application of this knowledge through the completion of a project-based learning activity of your choice dealing with these skills. For this activity you will use the 8th Grade Mathematics Projects list to select a project to complete to show your knowledge base on these skills.

Time	Activity	Comments
2 mins	Each group will receive a group list of the 8th Grade mathematics projects. Group moderator will display list for group to see options.	Moderator, recorder, summarizer job will rotate weekly throughout the group. All will hold each roll eventually.
3 mins	The project choices for this week that deal with this skills set are projects #2 and #13. Group moderator will use the round table strategy and call on members to voice their project selection choice. Recorder will tally votes, most votes will be the group project for this week. (In the event of a tie, moderators vote is the tie breaker).	
25 mins	After project is selected, students will work daily on the group projects during independent practice time. Groups will be responsible for gathering needed materials to complete their projects. If any additional items are needed, groups must notify teacher by end of the first day of the week for teacher to get supplies for next class day.	
5 mins	The group summarizer will vocalize what the group has learned that day with the rest of the group, and record it in math journal for this study and class. Project group summaries will be shared with rest of the class during open discussion time in the last week of the quarter.	

Weekly Lesson Plans

Week 6

Skills: N-Q1/AL4; 8-F2/AL10; 8-F4/AL13

Lesson: Interpreting Data and Functions **Participants:** Whole Class/Both Groups

Time Required: 25 minutes

Goal of Activity: To activate students' prior knowledge on the concepts of interpreting data and functions in order to identify misconceptions and preconceived ideas and address them before applying the content.
Phase of Cycle of Instruction: Introduction and Guided Practice

Cycle of Instruction:	
Introduction	Class will be given a bell ringer problem that will require them to active prior knowledge to solve and explain.
	Teacher will use bell ringer problem to transition into the lesson on interpreting data and functions. Teacher will review collecting and interpreting data, multistep problems, mathematical communication, and function tables. This will be done on whiteboard/SMARTboard via teacher made example problems.
	Students will view examples, discuss and explain the process as a whole group, record findings into notes for future reference.
	All groups will remain in whole group for guided practice
Guided Practice	After the lecture, the teacher will create examples on the whiteboard/SMARTboard for students to work individually on in order to apply the skills taught. The teacher will rotate throughout the room, answering questions, and affirming students on their findings.
Treatment groups will move into PBLA groups at this point for independent practice	
Control groups will work on individual problem sets given by teacher for independent practice	

Student Independent Practice
Week 6 – Interpreting Data and Functions

Group Moderator____
Group Recorder____
Group Summarizer/Timekeeper____

Phase of Cycle of Instruction: Independent Practice

Introduction 	The purpose of this activity is to activate your prior knowledge on the concepts of interpreting types of data and functions in order to show application of this knowledge through the completion of a project-based learning activity of your choice dealing with these skills. For this activity you will use the 8th Grade Mathematics Projects list to select a project to complete to show your knowledge base on these skills.

Time	**Activity**	**Comments**
2 mins	Each group will receive a group list of the 8th Grade mathematics projects. Group moderator will display list for group to see options.	Moderator, recorder, summarizer job will rotate weekly throughout the group. All will hold each roll eventually.
3 mins	The project choices for this week that deal with this skills set are projects #3, #6, #12, and #14. Group moderator will use the round table strategy and call on members to voice their project selection choice. Recorder will tally votes, most votes will be the group project for this week. (In the event of a tie, moderator's vote is the tie breaker).	
25 mins	After project is selected, students will work daily on the group projects during independent practice time. Groups will be responsible for gathering needed materials to complete their projects. If any additional items are needed, groups must notify teacher by end of the first day of the week for teacher to get supplies for next class day.	
5 mins	The group summarizer will vocalize what the group has learned that day with the rest of the group, and record it in math journal for this study and class. Project group summaries will be shared with rest of the class during open discussion time in the last week of the quarter.	

Appendix J

Teacher Fidelity of Implementation Form

Modified from Fidelity of Implementation Framework (Century, Rudnick, & Freeman, 2010)

Directions: Place a mark in the square that best describes how you feel about each statement.

	Never	Hardly Ever	Some-times	Fairly Often	Very Often	Comments
Procedural						
1. The teacher remained on the intended time schedule for the activity.						
2. The teacher used assessment tools.						
3. The teacher followed the lesson order set in place by the lesson plan.						
Pedagogical						
4. The teacher facilitated cooperative groups (only answer for PBLA group)						
5. The teacher facilitated class discussion (only answer for traditional group)						
6. The teacher facilitated in student autonomy						
Student Engagement						
7. The students contributed to cooperative group work. (only answer for PBLA group)						
8. The students engaged in class discussion. (only answer for traditional group)						
9. The students completed the PBLA successfully.						

Additional Comments (classroom climate, level of enthusiasm, feedback, etc.):

Appendix K

Teacher Fidelity of Implementation Form - Results

Modified from Fidelity of Implementation Framework (Century, Rudnick, & Freeman, 2010)

Teacher Fidelity of Implementation Form

Modified from Fidelity of Implementation Framework (Century, Rudnick, & Freeman, 2010)

Directions: Place a mark in the square that best describes how you feel about each statement.

	Never	Hardly Ever	Some-times	Fairly Often	Very Often	Comments
Procedural						
1. The teacher remained on the intended time schedule for the activity.				✓		
2. The teacher used assessment tools.				✓		
3. The teacher followed the lesson order set in place by the lesson plan.				✓		Stayed on task as much as time allowed
Pedagogical						
4. The teacher facilitated cooperative groups (only answer for PBLA group)				✓		
5. The teacher facilitated class discussion (only answer for traditional group)				✓		
6. The teacher facilitated in student autonomy				✓		
Student Engagement						
7. The students contributed to cooperative group work. (only answer for PBLA group)				✓		
8. The students engaged in class discussion. (only answer for traditional group)				✓		
9. The students completed the PBLA successfully.				✓		

Additional Comments (classroom climate, level of enthusiasm, feedback, etc.):

- Students enjoyed the PBLA - asked to continue in future
- Traditional group wanted to use PBLA over worksheets - got mad when I wouldn't let them.

Biographical Sketch

Biographical Sketch

Rachel Marie Mudrich was born on August 19, 1985 in Tuscaloosa, Alabama to Barry and Karen Jenkins. In 2007, she received her Bachelor of Science in Early Childhood and Elementary Education from the University of Mobile where she was also selected as President of the Kappa Delta Pi Educational Honor Society. Rachel went on to pursue and receive her Master of Science in Instructional Design and Development in 2012, from the University of South Alabama. Rachel currently resides in Wilmer, Alabama. She is employed as a language arts and mathematics teacher at Semmes Middle School. Rachel currently has one publication. Rachel is married to her husband, Jonathan, and they have three children, Stetson, Shiloh, and Baby Mud, set to arrive July 2017. Rachel will complete her PhD in Instructional Design and Development in May 2017.

Mudrich, R. (2013). *Instructional Strategies and Teaching Methods: Are They One and the Same?*. In R. McBride & M. Searson (Eds.), Society for Information Technology & Teacher Education International Conference 2013 (pp. 4513-4524). Chesapeake, VA: Association for the Advancement of Computing in Education (AACE).