INTEGRATING PROJECT-BASED LEARNING INTO AN OUT-OF-SCHOOL TIME SETTING TO ENHANCE STUDENTS' EXPERIENCES WITH MATHEMATICS AND THEIR UNDERSTANDING OF MATHEMATICAL CONCEPTS

by

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According to the curriculum principle set forth by the National Council of Teachers of Mathematics (NCTM), the mathematics curriculum should grab students' attention, be worth their time, and prepare them for problem-solving situations in a variety of settings such as school, home, and work (NCTM, 2000). The learning principle states that for a student to learn and understand mathematics they must actively build new knowledge from prior knowledge and experiences (NCTM, 2000). Creating a curriculum based on these principles, which align with the goals and theories set forth by Project-Based Learning (PBL), would provide students with a learning environment conducive to their achievement in and conceptual understanding of mathematics.

The fundamental idea of PBL is that real-world problems capture students' interests and provoke cognitive thinking skills as the students acquire and apply new knowledge in a problem-solving context (Alexander, 2000; Heyl, 2008; Thomas, 2000). The benefits of PBL have been well researched (Barron et al., 1998; Blumenfeld et al., 1991; Heyl, 2008; Petrosino, 2004; Tal, Krajcik, & Blumenfeld, 2006; Thomas, 2000). Although the tenets of PBL are research-based, and deemed as best practice according to the NTCM principles, there is still criticism about using PBL as a means of delivery of the mathematics curriculum. With the increasing demands of high-stakes testing, teachers have difficulties finding the time and resources to incorporate PBL into the school day (Seidel, Aryeh, & Steinberg, 2002).

Due to the lack of time and resources within the classroom, other avenues must be investigated that will allow PBL to be utilized in an effective manner. The use of Out-of-School Time (OST) provides an opportunity to supplement learning and provide assistance to students with needs that extend beyond a regular classroom setting (NCEE, 2009; Lauer et al., 2004). OST is the period when students are outside of school but not with their parents; these periods can include summer break and before- and after-school. The implementation of PBL experiences within OST allow for strategies that will focus on student deficiencies that cannot be satisfactorily addressed in the time allotted in a traditional classroom (Lauer et al., 2004).

Literature Review

Project-based learning is grounded in constructivist beliefs. Constructivism is the educational theory within which individuals are assumed to construct their own meanings and understandings based on existing knowledge and beliefs which intertwine with new knowledge and experiences (Yilmaz, 2008). Maclellan and Soden (2004) state implications of constructivism as follows:

- Learners are intellectually generative (with the capacity to pose questions, solve problems, and construct theories and knowledge) rather than empty vessels waiting to be filled;
- Instruction should be based primarily on the development of learners' thinking;
- The locus of intellectual authority resides not in the teacher nor in the resources, but in the discourse facilitated by both teachers and learners. (pp. 254-255)

John Dewey's work contributed to the constructivist view that knowledge is not discovered but constructed by the mind (Richardson, 2003). In his book, *The Child and the Curriculum*, Dewey (1902) states the following: "Learning is active. It involves reaching out of the mind." (p.256) Students must experience in order to learn (Phillips, 1998). Phillips further interprets this aspect of Dewey's work as trying to bridge the gap between the students' interests and the logically formulated curriculum. Throughout Dewey's writings, there are themes of learner-centered instruction and students thriving in learning environments that allow them to interact with the curriculum. This "learning by doing" aspect is the basis upon which project-based learning is derived (Heyl, 2008, Barron et al., 1998; Blumenfeld et al., 1991). Heyl (2008) further states that Dewey's theory is not only based on students' engagement in experiences but also builds upon their previous knowledge to construct new knowledge with guidance.

Kilpatrick, a former student of Dewey, worked within the realm of progressive education. As a result of Dewey's teachings, Kilpatrick generated the notion of the project method, now referred to as Project-Based Learning (Parker, 1992). The project method gave Dewey's child-centered educational theories a practical teaching methodology, providing students with active, interest-motivated, and life-like activities (Parker, 1992). By using this method, Kilpatrick (1918) believed that students who participate in purposeful acts will emerge with a prolonged higher degree of skill and knowledge.

In terms of the social aspect of learning, Vygotsky believed knowledge is co-constructed. Learning involves more than one individual student and is created through interactions with other students, their teachers, and the environment (Vavilis, 2003). This idea is best illustrated in his findings on the zone of proximal development (ZPD). Vygotsky (1978) refers to the ZPD as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). Through this social interaction, students are guided through active-learning processes and achieve beyond their actual level of development, increasing their level of functionality and ability (Vavilis, 2003).

Through the theories of constructivism, the fundamental ideas of Project-Based Learning (PBL) are derived. PBL involves authentic, child-centered, active, hands-on, and social experiences, which allow students to acquire and apply new knowledge. A key component of

PBL experiences is their ability to engage students in learning. The interest students have toward the projects affect how motivated they are to participate in them (Blumenfeld et al., 1991).

Project-Based Learning activities are open-ended, challenging, and experimental in nature, building on and enhancing children's learning (Alexander, 2009). A further look into a study performed by Krajcik et al. (1998), involving a project-based, middle school science classroom, helps to define several factors that formulate the design principles of a successful PBL experience. The project within the study was broken down into three main parts: the Introductory Unit, Project One, and Project Two. The Introductory Unit involved students in exploring how to identify a substance. For Project One, students investigated the kinds of materials that decompose and, in Project Two, students explored water and its uses. Specific aspects of these projects will serve as examples of the features involved within PBL.

First, PBL projects are the curriculum. Students should encounter and learn central concepts via the project (Thomas, 2000). For example, in Project One (Krajcik et al, 1998), students investigated answers to the question revolving around types of garbage that decompose. In the context of this project, students explored the concepts of decomposition, recycling, renewable and nonrenewable resources, biodegradability, solid waste disposal, nature's cycles, and interdependence.

Secondly, PBL projects are focused on clear and appropriate goals that embrace academic, social, and cognitive dimensions (Barron et al., 1998; Seidel et al., 2002; Tal et al., 2006). Within the realm of PBL, these goals are typically organized around questions or problems that drive students to encounter the central concepts (Barron et al., 1998; Thomas, 2000). A driving question is unique to PBL because it provides activities that are orchestrated with a purpose (Blumenfeld et al., 1991). The introductory unit and both projects within the

Krajcik et al. (1998) study all began with a driving question: *How can you tell what substance is if it has lost its label?*, *Where does all our garbage go?*, and *Water water everywhere! Is there enough to drink?*, respectively. The questions serve as an organizational element that helps to direct activities which lead to outcomes of significance, such as written and oral presentations (Seidel et al., 2002, Thomas, 2000, Blumenfeld et al., 1991, Krajcik et al. 1998, Tal et al., 2006). For example, for each of the aforementioned projects, students gave two oral presentations, one at the beginning and the other at the end of their investigation. In the first presentation, students described their initial research questions, experimental designs, and plans. The concluding presentation involved students presenting their analysis and conclusions. The information provided during the oral presentations was also converted into a final written report.

Thirdly, projects involve student-driven, constructive investigations within realistic and authentic contexts. This allows for connections between elements within the classroom and real-life experiences (Blumenfeld et al, 1991). Within each project, Krajcik et al.(1998) describes that students were responsible for creating their own plans, choosing appropriate materials, and determining how to sequence activities within their investigation. Teachers played an influential role in guiding students through the questions presented in the projects by being a facilitator and scaffolding student inquiry. Teachers supported students by modeling the inquiry approach, providing examples, suggesting strategies, and giving feedback. One important way to scaffold open-ended projects is to allow for student reflection (Barron et al., 1998), which students were able to do through the practice of keeping a notebook throughout the projects. Within the context of an investigation, projects aid in the transformation and construction of student knowledge based within an authentic, real-world setting (Thomas, 2000).

Lastly, projects should have on-going assessment (Barron et al., 1998; Lauer et al., 2004; Seidel et al., 2002). Krajcik et al. (1998) illustrate how students were evaluated throughout the duration of the projects. As previously stated, students gave two oral presentations, for which they were asked for explanations or clarifications and given feedback for improvements and revisions. Artifacts, including laboratory notebooks, tests, and reports were also assessed

Projects as the curriculum, clear and appropriate goals, student-centered, authentic experiences, and on-going assessment are the main criteria of PBL that need to be in place to allow for reinforcement and enrichment regardless of the student level. Benefits of successful implementation of PBL include enhancing student motivation and attitude, as well as increasing their abilities to understand, use, and present concepts (Barron et al., 1998; Blumenfeld et al., 1991; Heyl, 2008; Petrosino, 2004; Tal et al., 2006; Thomas, 2000). The two studies that follow illustrate these benefits within the context of PBL experiences.

In a three-year case study of two schools in the United Kingdom, Boaler (1998) compares a traditional teaching approach to an open-ended, project-based approach. The study was performed with students ages 13 to 16. The two schools had similar student demographics. The school referred to as Amber Hill used the content-based, traditional instructional method while Phoenix Park, used the project-based approach. Boaler monitored the relationships between the students' experiences with and their developing understandings of mathematics using a number of assessments, including a national examination, observations of students, conversations, and questionnaires.

Amber Hill students gained knowledge through textbooks and direct instruction and students at Phoenix Park were introduced to new concepts and procedures through authentic activities. The teachers at Amber Hill explained mathematical methods to students and then they were given a series of exercises to practice the methods. On the other hand, Phoenix Park students were placed in mixed-ability groups and worked on open-ended projects for which they were encouraged to develop their own ideas and formulate and extend problems. Students in both schools performed the same on traditional, standardized test questions. However, when students were given assessments based on realistic situations, Phoenix Park students received higher scores. Amber Hill students found it difficult to apply knowledge to anything other than traditional textbook-style questions.

Through student assessments and interviews with teachers and students, Boaler (1998) was able to identify influential factors that led to students' development of mathematical understanding and beliefs about the nature of mathematics. Students at Amber Hill had views based around the importance of remembering rules, equations, and formulas which seemed to have negative implications. Instead of gaining a sense of understanding students were under the notion that they just had to remember what was taught. This led to the development of limited procedural knowledge that did not transfer to unfamiliar situations.

Students at Phoenix Park developed conceptual understandings that provided them with a wide range of advantages in a variety of situations including assessments. The act of using mathematical procedures within authentic activities allowed for these students to manipulate methods to fit new situations. Students at Phoenix Park also developed more positive views about mathematics (Boaler, 1998). Student involvement in PBL experiences at Phoenix Park demonstrate the benefits of increased motivation, improved conceptual understanding, and the ability to extend gained knowledge beyond the walls of the classroom.

Another study that illustrates the benefits of PBL involved a case study performed by Petrosino (2004), in which a teacher engaged his ninth through twelfth grade students in a PBL learning experience for five weeks in an elective, astronomy class. Data included teacher interviews, e-mail correspondences between the teacher and his colleagues, teacher's lectures and notes, handouts, computer programs, class projects, curriculum guides, and handouts. The purpose of this study was to observe the connections between knowledge, learner, assessment, and community and their impact on current practices.

The PBL experience occurred through the use of a Hands on Universe (HOU) high school curriculum. The program integrates mathematics, science, and technology in the context of authentic astronomical explorations (Petrosino, 2004). HOU enables students to request data from professional observatories. Students download images and use image-processing software to visualize and analyze data. The curriculum was arranged so that students undertook a series of individual projects throughout the year. By doing so, students were able to satisfy course requirements while being engaged throughout the duration of the class.

Almost all classes began with an instructional cycle which included a conceptual lesson-activities-contextualization. The introduction presented conceptual understandings of the topic to which students would later relate the HOU curricular activities. Through the course of the unit students collaborated with a number of scientists, teachers, and other students via email to share ideas and discuss data and astronomical findings. Upon completion of their projects, students were given detailed explanations of their progress (Petrosino, 2004).

Throughout the curricular unit a number of findings emerged. First, the entire class shared the knowledge base of its participants by which students emerged as experts of the subject matter. Students took on the role of doctoral scholars by conducting real research on data not previously analyzed by other scientists. Secondly, students viewed the class as a way of learning any subject matter not just astronomy. Students also became part of a larger community. They were able to reach beyond the walls of the classroom and collaborate with others in the outside world (Petrosino, 2004). These findings, which also correspond to the findings in the Boaler (1998) study, go hand in hand with the benefits provided through PBL experiences. In both scenarios students developed an increased ability to understand, use, and present concepts learned, and demonstrated an enhanced attitude toward the subject.

Regardless of the benefits provided by PBL experiences, which include increased engagement, improved understanding of mathematics, a bridge between school and real life, and a higher level of thinking (Heyl, 2008; Krajcik et. al., 1998; Tal et al., 2006; Thomas, 2000), there are major hurdles in implementing these experiences in the classroom. Some of these challenges include a lack of support of student learning, difficulty with assessment, and constraints on time and resources (Barron et al., 1998; Petrosino, 2004; Seidel et al., 2002; Thomas, 2000).

Teachers find it challenging to provide students with an environment conducive to PBL. These environments maintain order while at the same time allow productive conversations and activities. At the same time, teachers have difficulty scaffolding students' activities, giving them too much independence with little modeling and feedback (Marx et al. 1997).

Within PBL experiences, designing assessments that measure student understanding presents itself as an obstacle (Marx et al, 1997). Teachers find it hard to decipher what has and have not been learned and cannot adapt their instruction accordingly (Barron et al., 1998). Even the artifacts that students produce do not always require students to synthesize information or represent conceptual understandings grained through the project (Marx et al, 1997).

With the increasing demands of high-stakes testing, teachers have difficulty in finding the time and resources to incorporate PBL into the school day (Seidel et al., 2002). PBL experiences may take longer than anticipated in both their creation and implementation (Marx et at., 1997). Projects should be flexible and might require diverse resources such as a specialist from the community who can aid with specific or difficult subject matter (Seidel et al., 2002). There is also the challenge of being able to implement a PBL curriculum and still be able to meet the curriculum guidelines mandated by a district (Marx et al., 1997).

Heyl (2008) further discusses the contradictory expectations between the constructivist approach, upon which PBL is based, and standardized testing, which is now often the driving force of the curriculum. The discrete skills being tested are not conducive to the problem solving skills, which are applicable to real-world problems, gained from PBL. However, as seen in the Boaler (1998) study, students who followed the PBL approach, not only performed well on standardized testing but also gained knowledge that could be used beyond the walls of the classroom.

Out-of-School Time (OST) presents itself as a possible solution to this dilemma. According to the National Center for Education Evaluation and Regional Assistance (NCEE) (2009), OST experiences will help to close the achievement gap between high- and low-achieving students. OST is the period when students are outside of school but not with parents. This time provides an opportunity to engage students in more active learning (Seidel et al., 2002). There is significant debate as to how OST, especially after school hours, should be used with respect to the content and style of learning being implemented. The questions revolve around what should be taught, how it should be taught, and whether the strategies used are effective. In terms of OST, these questions are constantly being evaluated (Seidel et al., 2002).

Beckett et al. (2009) provide certain recommendations for best practices during OST. The recommendations resulted from several studies. The first year of findings provide some indication that instruction in an OST setting can improve student achievement when delivered in a structured, focused format with adequate dosage. The study recommends that “OST activities be interactive, hands-on, learner-directed, and related to the real world, while remaining grounded in academic learning goals” (Beckett et al., 2009). This recommendation aligns with the goals and objectives of a PBL curriculum. Allowing such engagement will also help to overcome student fatigue after a long school day (Beckett et al., 2009). PBL experiences can provide more intentional and planned learning experiences while still offering many of the attractive qualities of play (Alexander, 2000). Despite the guidelines laid forth by Beckett et al., few programs were found that showed evidence of meeting this recommendation

There is much debate when it comes to how to use OST in terms of enrichment versus reinforcement (Seidel et al., 2002). Afterschool programs, with children who were perceived at risk of school failure, focused on homework, test preparation, and tutoring. Alternatively, students who were more successful in school would participate in programs that were different from what they would encounter in school (Seidel et al., 2002). However, Seidel, Aryeh, & Steinberg (2002) further noted that PBL experiences can simultaneously serve both academic reinforcement and enrichment goals. The use of PBL in an OST setting provides a bridge that connects students’ various worlds into learning experiences that become meaningful and relevant to their life (Noam, 2003). Students need to have a reason for and understanding of what they are doing and learning which in turn provides added value to situations beyond the walls of the classroom.

Several studies have provided a wealth of knowledge about PBL such as guidelines for PBL and examples of PBL experiences (Seidel et al., 2002, Alexander, 2009, Noam, 2001)**.** Notwithstanding these examples, Seidel, Aryeh, and Steinberg (2002) and Noam (2003) both state that there is little direct research that can be found on the effectiveness of project-based curricula, especially in OST settings. Noam writes, “We recognized, along with many others working in the field of after-school education that without empirical evidence in the form of quantitative analyses, qualitative investigations, or even compendia of best practices, this emerging fold of after-school education will make only marginal progress” (p.126). Furthermore, even among the empirically-based PBL studies, the activities were geared toward middle and secondary students and often dealt with scientific content. Due to this lack of empirically-based research, I propose to expound upon these findings by implementing a PBL mathematics curriculum within an afterschool program to a group of fourth and fifth graders. In particular, my research will focus on two main questions:

1. In the context of mathematics, how do the conceptual understandings and problem-solving skills of fourth and fifth graders develop through PBL in an OST setting?
2. How do students’ attitudes toward mathematics change after participating in PBL in an OST setting?

Methods

Participants

The participants were a group of eleven students in grades ranging from second to sixth. These students attend the afterschool program at the Harris Community Center (pseudonym). Harris Community Center is 1 of 22 citywide community centers. It is located in a large city in the Southwest United States. Harris Community Center offers a variety of recreational and educational activities for the community, including an afterschool program for children ages 5 to 13. The students in the program are able to participate in recreational, cultural, and educational activities five days out of the week. The following are brief descriptions of the participants. (All names are pseudonyms.)

- Derin is a third grader who was present every day. She came in each day prior to the start of the project to ask when it would begin. When working with her group she always had a smile on her face and was happy about whatever task she was completing, whether it was a part of the project or off-task endeavors.
- Edmond is a third grader and sibling of Katie. He wanted to quit the first day of the project but his mom insisted on him being a part of the program. He was defiant at times and had difficulty following directions. He was absent one day.
- Eugene is a sixth grader who was present every day of the project and was very talkative with his peers. He had little motivation and was quick to lose interest.
- Jason is a third grader who had a hard time staying focused throughout the entire project. He was absent one day but had to leave several minutes into the project on two other days.
- Katie is a fifth grader and sibling of Edmond. She was very helpful and always asked what she could do to help prior to the project, like setting up the chairs and tables and organizing the group bins. She got along well with her peers and was the voice of reason for her group and others. She was absent two out of the seven days.
- Kristy is a fifth grader who was absent three of the seven days. She was very enthusiastic and was always able to provide comic relief for her group.
- Leon is a fourth grader who was absent one day. He was very opinionated and displayed inconsistent behavior; at times he felt like participating and other times he did not.
- Mary is a fifth grader and sibling of Trudy, was absent three of the seven days. She was very outgoing and boisterously voiced her opinions.

- Ryan is a fourth grader who was absent three days. He was very persistent in trying to be helpful throughout the project, but was intimidated by challenging tasks. He was content when he had something to do to contribute to his group's project.
- Susan is a fourth grader who was present every day and took on the leadership role in her group. On the days her dad came to pick her up early, she asked to stay longer.
- Trudy is a second grader and sibling of Mary. She displayed a number of cooperative qualities and did her best to try and organize her group. She was absent two days and left early the first day during the pre-assessment and pre-survey.

I was both the researcher and teacher during the study and referred to as Ms. Linda throughout.

Data Collection

The data collected included surveys, assessments, checklists, field notes, audio recordings, student mathematics journals and notebooks, and a group discussion. The survey (Appendix A) was used to identify the students' attitude toward mathematics, and was administered both before and after the PBL experience. Students took the pre-assessment (Appendix B) which covered potential mathematical concepts that students might have encountered during the project. Students then took a post assessment (Appendix C) once the project was completed. The pre- and post-assessments are not identical but similar to each other. A checklist (Appendix D) was completed by the researcher every other day for each student. The checklist monitored student behaviors in terms of attitude towards assignments, conceptual understandings, problem-solving processes, and collaborative work. Extensive field notes were taken each session. The field notes documented student interactions, student dialogue, and informal and formal assessments made by the researcher.

Students were recorded while they worked during each session. The students were randomly divided into three groups: Group A (Derin, Susan, Leon, Kristy), Group B (Mary, Katie, Jason, Ryan), Group C (Trudy, Edmond, Eugene). Only Group A and B were transcribed and analyzed, due to grade and maturity limitations. Group C was not transcribed because two members were in the second grade and the third lacked maturity and motivation. Each student had a mathematics journal that contained a collection of responses to questions involving conceptual understandings, perspectives, and problem-solving techniques. (Refer to Appendix E for sample journal prompts.) The mathematics notebook was a three-ring binder in which each group maintained artifacts that students created throughout the course of the project. At the end of the project and its components, students participated in a group discussion about their thoughts of PBL and whether or not their attitude towards mathematics had changed. (Refer to Appendix F for the questions for the semi-structured discussion.)

Data Analysis

To gain insight into the changes in students' conceptual understanding of, problem-solving skills in, and attitude towards mathematics, the data were analyzed using both qualitative and quantitative methods. The qualitative data collected included the pre- and post-survey, checklists for each student, the close-analysis group recordings, mathematics journals and notebooks, the small group discussion, and extensive field notes. The data collected was analyzed using the constant comparative method (Glaser & Strauss, 1967). The data were coded and the codes were categorized based upon related themes. Additional data analyzed were compared with previously coded data and merged into corresponding categorizes or expanded into new categories. To support the qualitative data analysis, quantitative data were gathered from the pre- and post-assessments. The data were analyzed using descriptive statistics to measure the changes in group and individual central tendencies in terms of the students' problem-solving skills and conceptual understanding.

Procedure

Upon receiving approval from the IRB committee, parent permission forms (Appendix G) were given to parents to sign. I met with the group of students whose parents/guardians granted permission and gave each of them an assent document (Appendix H) which was read aloud. Afterwards, students were given the opportunity to ask questions. They then indicated whether they wanted to participate by signing the assent document. Next, students completed a pre-assessment to determine their level of understanding of the mathematical concepts that were presented throughout the project. The students were also given a pre-survey about their perceptions of and attitudes toward mathematics. The program, which incorporated a project-based curriculum, was taught one and one half hours for five days (Appendix E). The students worked in groups that were formed by a third party and their interactions were recorded. Each student was given a one-subject notebook in which they responded to the journal prompts. In addition, each group kept a binder of all of their work throughout the project.

The project-based program, created by the researcher, was a mathematics curriculum which aligns with the National Council of Teachers of Mathematics (NCTM) standards. The overall project involved students designing a restaurant and its menu answering the overarching question: What is involved in planning and opening a restaurant? The first part of the project comprised students having a budget to purchase flooring and furniture for the dining area. For the second part of the project, students designed menus for the restaurant. Each group chose a number of recipes that were used to create the appetizers, entrees, and desserts for their menus. They were informed that they would be hosting a grand opening of their restaurant and 50 people had confirmed to attend. Based on the serving sizes, students had to discover how much food they would need.

They were responsible for creating a grocery list of necessary items that fit within their budget. Groups then designed an electronic version of the menu.

Upon completion of the project, students participated in a small-group discussion about their views and opinions of their experiences. Finally, students were given a post-assessment and post-survey, which emulated the pre-assessment and pre-survey.

Findings

During the study three major themes emerged: the effect of student experiences on learning, the learning and sharing of content knowledge, and the challenges encountered. Students had a variety of experiences that affected their attitude toward the project and mathematics. Students dealt with moments of frustration and combated feelings of helplessness throughout their learning experience. Upon completion of the project, a majority of the students were able to reflect back on these experiences in a positive light. The interactions that students had with their peers and the instructor allowed them to gain knowledge. Students were able to use prior knowledge and collaborate with one another to gain better understandings. The instructor was able to scaffold student learning which also led to comprehension. Despite the positive experiences there were a few challenges that affected learning as well. These challenges included frequent absences, lack of team development, maturity issues, and teacher dependence.

Student Experiences

The experiences students had throughout the project along with the self-efficacy qualities they possessed affected students' attitudes and how they approached and worked through problems. Throughout the project, students experienced moments of frustration due to not being able to grasp the concept and/or having little support from other group members. Those, who showed signs of self-efficacy such as, being confident and showing persistence and enthusiasm were able to work through the frustration. On the other hand, the students who did not possess those qualities had difficulties to dealing with the frustration which led to off-task behavior and negative attitudes towards the project. There were many occasions in which students displayed a sense of helplessness which prevented them from taking risks and opening up to the idea of learning unfamiliar content. At the end of the project, students reflected on their experience. Regardless of the negative feelings or attitudes toward mathematics or the project, students understood the importance of it.

Frustration.

The checklist (Appendix D) provided insight into how students dealt with the various levels of frustration. The checklist was completed three times throughout the course of the project. Students were given a check mark if they displayed problem solving skills, positive attitudes, and good cooperation. In most cases, those who were confident, and who showed persistence and enthusiasm, were able to consistently work through the frustration. Susan was one of the students who received checks in each of those areas on a consistent basis.

For example, in the following scenario Susan, a fourth grader, and Derin, a third grader, tried to find the area of the restaurant space to determine the amount of carpet they would need to cover the floor. The scaled floor plan depicts two feet as one-half inch. When Derin's mom came to take her home, Derin begged her to stay and she joined Susan and Derin at their table.

Susan So, I don't know what's going on right now, because I'm not sure how to do this.

Derin I know what chairs we can use.

Susan Derin, you need to be helping me. Stop messing with the chairs. What is up with you and that book? Like, you two are, like, friends or something.

Derin Because.

Parent I thought you said one and a half… wait. It says a half inch.

Susan Yes. A half inch…

Derin I know how to measure it.

Susan Should be square feet. So, I'm not really sure what's going on right now.

Derin So that is four feet.

Susan Derin…

Derin Four… that's three… six…

Parent But the math for it, you're on your own.

Derin Seriously?

Parent Yes, you've got to do something on your own, so you might as well act.

Derin Okay.

Susan What? Times what? Okay, well I get flustered.

Susan was busily working on finding the area, while Derin was distracted looking for furniture instead of helping Susan with the computations. Derin's mother tried to assist Susan while Derin read random numbers off of the paper. Not only was Susan unaware of how to do the mathematics, she also lacked support from her other teammate. Susan became frustrated trying to find the area of the space. Later that week, Susan wrote in her journal: "I felt very frustrated but I got over it and got it together." Due to her persistence, Susan was able to overcome her frustration.

Based on the checklist, Katie showed the same self-efficacy characteristics as Susan in the previous scenario. Katie had to approach the challenging problems with no help from her group members. However, she was able to work through her frustration. When Katie was working on finding the amount of food needed to serve 50 people at her groups' restaurant she uttered a single phrase that summarized her frustration about the work:

Katie ...mathematical, hair pulling out, worthy.

Katie's other group members were gone that day so she was with two members from Group C, Edmond and Eugene. While Edmond and Eugene spent most of their time off task, Katie continued to work without giving up.

Katie I've been working on the same recipe for about 20, 30 minutes and I'm not done with the recipe yet. I have to still work this out.

Seeing Katie's frustration with the work, Ms. Linda stepped in and assisted Katie with her misunderstandings and confusion. Ms. Linda and Katie talked back and forth to determine how many containers of sour cream, one of which contains 30 tablespoons, would be needed for five of the same recipe.

Ms.L That's what I want to know, is how many cups is that? In [one container of sour cream] is 30 [tablespoons]. Wow, it's about...

Katie That is 30 divided by 16.

Ms.L So it's 1.8 [cups]. So it's about 1.8. So, we're going to make... You're going to make five recipes and how many [cups of] sour cream?
Five?
[*30 seconds of off task conversation between Edmond and Eugene, while Katie and Ms. Linda are calculating and writing out their work*.]

Katie Yes, that's 30... That's 30 tablespoons. Cups, we need five.

Ms.L You need five cups [for all the recipes combined].

Katie Right. Because one recipe [calls for] one cup. And we need five [recipes].

[*Katie calculates 1.8 times 5 and sees what it is equal to; she then calculates 1.8 times 4 to see how many cups that would equal.*]

Ms.L You see, that's already seven.

Katie So we only need four [containers of sour cream]?

Ms.L I would work around with that one. It seems like you wouldn't need...

Katie ...five. You'd need four.

Ms.L Because 1.8...

Katie So, you would get 7.2 [cups]. We'd only have to buy four [containers].

Ms.L Yes. Or maybe less. Because we only need how much?

Katie We need five cups [for the recipes].

[*Katie puts 1.8 times 3 into the calculator*]

Ms.L 1.8 times 3 is 5.4. It's 5.4 [cups].

I helped Katie work through her frustration and misunderstandings. Katie continued to work through the rest of the ingredients but was still overwhelmed by all the work that needed to be done and lack of support she was getting from her teammates.

Katie You know, I'm kind of stuck here, working all by myself.

The off-task behaviors and lack of support encountered in this situation added more frustration to Katie who was already struggling with a number of concepts and calculations. Katie was not with her regular group; instead, she was with two other individuals from Group C, who lacked self-efficacy, and whose attendance and immaturity had a negative impact on the work. (Attendance and maturity issues will be discussed later in the Challenges section which will provide more insight as to how frequent absences and lack of maturity caused a number of difficulties.)

In the previous scenarios, both Susan and Katie displayed a number of attributes, such as being confident and showing persistence and enthusiasm, which helped them work through the frustrations they encountered. On the other hand, there were students who did not show these self-efficacy characteristics and became defeated. For instance, Ryan did not receive any checks on the first two checklists and was absent the first two days of the project. The following interaction between him, his two other group members, and me illustrates his frustration.

Ryan I want to quit.

Ms.L …you do?

Ryan Yes, because it's hard. Nobody's helping me except [Ms. Linda].

Mich. It's not about helping. It's about working together.

In my field notes I commented:

"Ryan gets frustrated because he feels his group doesn't inform him enough about what they are doing…he wants to be told exactly what to do instead of discovering on his own."

The fact that Ryan lacked self-efficacy and had frequent absences led to the majority of his frustrations. As previously mentioned frequent absences were one of the challenges identified during the project and will be further discussed in a latter section.

Sense of helplessness.

Frustration was not the only factor that prevented students from completing the work. Many students also displayed a sense of helplessness; they felt they were unable to complete certain aspects of the project due to their perceived lack of knowledge based upon their grade level.

Susan I don't know what square feet is. I'm only in fourth grade.

Ryan What is diameter? I'm in fourth grade. You expect me to know what diameter is?

Katie Diameter is all the way across.

Susan and Ryan both expressed how being in the fourth grade prevented them from knowing certain mathematical content. Instead of trying to utilize the assistance of other group members or me, Susan and Ryan had succumbed to helplessness. Later in the project, Ryan once again mentions that he is only in the fourth grade.

Ryan We haven't even did this up in fourth grade, even.

Katie Well, that's good. You're getting ahead of your learning.

Katie counteracts Ryan's statement by letting him know that he can learn the content regardless of his grade.

Reflections.

Regardless of the negative feelings or attitudes toward mathematics or the project, students understood the importance of the project. As students reflected on their project experience, they had a number of comments about how the project related to real-world experiences and how the project differed from what and how they normally learned mathematics in their regular classroom. For example, in the post-discussion, Leon discussed the real-world implications of the project.

Leon I thought this project was, like, a good opportunity. [The project gave us an opportunity] to do something probably we've never done before, and we might have learned a lot of other things, like we might now want to, when we grow up probably start a restaurant and stuff.

Leon described the new experiences that students were given during the project. He indicated that the real-world experiences obtained during the project could give insight to future goals as well as enhance their content knowledge. Other students commented about how the project differed from what they had experienced in the classroom.

Ryan [The project was] like more fun. It's not boring

Leon Usually we do like 45 times stuff and all that; we do facts and we talk about operations and like values and stuff.

Susan [The project] math is much harder than usual math that you do in your class because you have to figure out how much you need, how much money you're spending, how much you've got left…

Mary Because usually when you do a project you don't have to create a restaurant. You don't have to buy stuff. You don't have to purchase it. All you do is just have to draw it, write the mathematicals, whatever it's called, and then well, that's what you have.

Susan Let's see, well, you had to figure out more, you had to think much more than you usually have to do when you're in a classroom. You aren't used to this kind of maths; you're used to easier maths. You're not used to this hard maths, so sooner or later you got used to the nice hard math and then it started to get easier and easier every day.

Students discussed the challenging and engaging aspects of the project. The idea that the project required more than a regurgitation of facts and procedures allowed students to gain insight to the idea of problem solving within real-world contexts.

Students were able to express their positive views of the project, but when students discussed their like or dislike for mathematics, no clear answer could be determined. Of the six students who participated in both the pre- and post-survey, three students stated their favorite subject was mathematics on the pre-survey. By the end of the project four of the six students specified mathematics as their favorite subject. This change occurred because of a student named Trudy, a second grader. On the pre-survey, Trudy stated : “I dislike math because it’s frustrating [the] way my math teacher teaches it” transitioning to “I like math because it’s easier” on the post-survey. However, during the group discussion, Trudy states the following:

Trudy Okay, I liked to decorate the words on the paper, and I do not like doing maths.

Another discrepancy was found within the group discussion, during which Susan contradicts herself within the same conversation. Towards the beginning of the discussion, Susan describes how she likes the project and mathematics.

Susan I enjoyed the project, all the math, but I [do] know that I do not want a restaurant when I grow up.

Later, she expressed her dislike of mathematics.

Susan What I liked the most is making the menu, and the thing I liked the least was the math.

As exemplified, the data provided an ambiguous message in regard to the students’ perspectives about mathematics.

Content Knowledge

Project-based learning allows students to gain understanding of concepts by engaging in tasks and working with and gaining knowledge from others. Students were given both pre-and post-assessments to measure their conceptual understandings. However, the short duration of the program didn't allow for accurate data to be gathered. Although the quantitative data were inconclusive, students were able to gain understanding of content through activating prior knowledge, scaffolding, group collaboration, and teaching each other. These factors were evident in the groups as they worked through the project. When students were able to relate past experiences to new ones they were activating prior knowledge, which in turn helped them to gain a sense of understanding of new knowledge. If students were in a state of confusion, I was able to guide them with scaffolding or they were able to work together to come to a solution. Once students grasped a concept, they were able to teach other students.

Prior knowledge.

The following example demonstrates how one student activates prior experiences of her peers. Jason, Susan, and Derin had been given the task of purchasing furniture for their restaurant and located booths and tables that they wanted to purchase. They then tried to decide what size table they would like to have.

Jason Susan, like this big (in reference to a table size)?

Susan No. Have you been to Cici's before?

Jason Yes.

Susan You know the big booths that you sit in?

Derin Yes.

Jason Yes.

Susan And the long tables?

Jason Yes.

Susan That's the kind of tables we need.

Jason I went there a long time ago and ate some pizza.

Susan was able to help her group members, who were aware of CiCi's design, grasp the dimensions of a table and booth sizes. They were then able to visualize the type and size of booths and tables that they were going to purchase and use in their own restaurant.

Not only were students able to activate prior experiences of their teammates, they were also able to use prior knowledge in a way that benefited the group's conceptual understandings. In the next interaction, Kristy and her group tried to decide on the number of tables they would need at their restaurant. Kristy recalled previous knowledge about remainders and shared it with her teammates

Kristy So we would need nine tables, because my teacher said even though you have… if you ever have a remainder, you can't leave those out. So you would need nine tables.

Kristy was able to relate her knowledge of remainders to this situation, which then allowed her group members to interpret the remainder in the context of the problem.

Scaffolding.

Scaffolding was used to help students work through their confusion. In the following situation, Katie was working with her group to determine the number of tables to have at their restaurant for a grand opening which 50 people would be attending. After the group decided that they wanted four chairs at each table, Katie divided 50 by 4. Confusion arose as she tried to figure out what to do with the remainder.

Ms. L So, if you say a remainder of a table, what would a remainder of a table look like?

Katie Half of a table?

Ms. L Do they make half of a table?

Katie No, there might be extras left. We'll have extra.

After a thought provoking question, Katie was able to work through her confusion. She realized that she could not purchase half of a table; instead, she would have to purchase a full table to accommodate the number of people that would be attending the grand opening.

Scaffolding, in another situation, helped students to discover how to find the area of an irregular shape. Katie and Mary were trying to determine how much carpet to purchase to cover their restaurant space. To do so, they needed to first find the area of the space which was in the shape of an irregular hexagon.

Ms.L This section here is missing, isn't it?

Katie So, that times that would equal this entire thing. This all over here… so, you have to subtract 24.

Ms.L Close, because isn't this its own little square?

Katie Yes.

Ms.L Which is also extra area. This is extra area that you do not need. So, what do you do with things you don't need? Yes. Say it.

Katie You subtract.

Ms.L So, the area of this… if you can find the area of this…

Mary You subtract it by whatever number you get here.

I was able to use Katie and Mary's knowledge of area to guide them to a deeper understanding of the concept. Once they were able to grasp the new concept, in relation to existing knowledge, they were able to devise strategies to develop a solution.

Group collaboration.

Working together to solve problems requires cooperation, communication and mutual respect. Students have to be active listeners while also openly sharing ideas and knowledge. These meaningful contributions helped the groups develop solutions to problems. As students worked to gain content knowledge, they encountered confusion along the way. However, by working together and collaborating, students were able to learn from one another. When students grasped a concept, they were more than willing to share their understanding with others. Students were also able to correct each other and themselves when they made errors.

Teamwork.

Students not only had to use a number of problem-solving skills, but had to also collaboratively come to agreements. In the following conversation Susan, Leon, and Kristy worked together to decide on the number of chairs and tables they would need at their restaurant. They were given a scenario in which they had to accommodate 50 people for a grand opening.

Susan So we need nine tables, right, but how many chairs? There's eight [chairs] at nine tables, and eight time nine…

Leon 72.

Susan Is 72, so…

Leon So that's… We need at least to get, like, to 60.

Susan So we need seven chairs and nine tables.

Leon 63. So that means there's going to be 63 places, 63 spots.

Kristy Okay, we can have eight tables, or we can have seven tables that fit eight, and then we're going to have 56 chairs.

Leon That equals 56. Eight chairs, seven tables.

Susan Eight chairs and seven tables.

Kristy Eight chairs and seven tables, like, all…

Leon 56. That's more, so we have other room left over.

Susan We'll have left over.

Leon Yes, we'll have left over.

Susan began by stating how many chairs and tables should be at the restaurant. Leon calculated the number of people that could be accommodated and voiced his opinion about having fewer chairs. Kristy had been listening to both ideas and suggested to the group an alternative set up in in which they would have enough chairs for 50 people and a few left over. Both Susan and Leon liked her idea and they all repeated the idea in agreement. The students were able to contribute their various ideas and displayed active listening which helped them all to come to an agreement as a group.

Effective communication and beneficial contributions also allowed Katie and Mary to find the area of their restaurant space to determine how much carpet they needed to purchase.

Katie Each half of an inch equals two feet. So, how many…two feet… each time I tell you to write down two, do two. Ready?

Mary Where?

Katie Just write it down on a piece of paper.

Mary How do you want me to write it down?

Katie Just write two each time I say two. Two. Two. Two. Two. So, you should have four twos.

Mary Yes.

Katie Two. Two. Two. Two. Two. Two. Two. Two. Two. Two. Two. Two. Two. Two.

Mary That [carpet] is 75 [cent] per square [ft.]…

Katie Well, don't worry about that right now [referring to the carpet samples]. [Katie points to the floor plan] Add those all up. See what you get.

Mary I like this [carpet]. Add them up?

Katie Yes.

Mary Add them up together?

Katie Then, write six more.

Mary Three, four, five, six… so, you want me to add them up?

Katie Yes.

Katie told Mary to write down the measurements as she called them out. They collaborated as a team to find the dimensions of the space. In another instance, this group worked together when trying to find the number of people they wanted seated at each table and how to draw the tables on the floor plan.

Katie You said [the diameter] was 24 feet?

Ryan Let me do it.

Katie 24 inches.

Mary If you split it in half, how many people… How many chairs do we have? I mean…

Katie Four at each table.

Mary How many tables?

Katie Tables? 14.

Mary 14. You put seven on seven. How many altogether? We have 50 people.

Katie Right. We have 14 different tables, and they're each… they're…

Mary You're going to have to [draw this out] if you want to…

Katie I know. They are 24 inches in diameter (Katie began to draw a circle onto the floor plan), so this is how long the tables are going to be for us, and then half of it's going to be over here and half is going to be over here.

This dialogue displayed group collaboration, in which effective communication was used to work toward a shared goal.

Teaching and correcting each other.

Other forms of group collaboration were demonstrated through teaching and correcting one another. Active listening helped students to challenge miscalculations and other incorrect information. In the following excerpts, students were able to help other group members and correct misconceptions, which lead to a better understanding and necessary revisions.

One of the tasks students were given was to find the amount of carpet they would need for the restaurant. This process required students to find the area of the floor, choose the desired carpet, and then purchase enough of it to cover the floor. In the conversation that follows, Leon is concerned about how much money they spent on carpet. Susan clarified.

Leon We only spent, like, $500 on one [square of carpet]…?

Susan Not on one square. It should cover our whole restaurant.

Leon was under the misconception that one square foot of carpeting was $500. Susan's understanding of area and square feet allowed her to help Leon as well as students in other groups. She explained to Eugene, from Group C, how she got the area of the irregular floor space at her group's restaurant.

Susan So… but there's 24 across. There's 24 up. and there's 24 all the way around.

Eug. So you multiplied…

Susan So, 24 times…

Eug. 4

Susan No. 24 times 24.

Eug. 24 times 24?

Susan Yes. And then I got 576. And then, this [part], it was 12, 12, 12. So, 12 times two. I mean, 12 times 12. We got 144. And then I added, and that's how I got the total of how many squares it were going to be. Then this times how much it was going to be [for the carpet]…

Susan began by showing Eugene the length and width of one piece of the irregular shape represented on her floor area. Eugene asked if she multiplied those numbers and assumed she multiplied them by four which would give the perimeter of the square. However, Susan told him that she multiplied the two dimensions to get the area and Eugene became puzzled. Susan then further explained how her group found the area of the other piece of the irregular shape and how they added both of the areas to come up with the total area of the entire region. By talking to Eugene about how her group found the area, Susan was able to convey a strategy to him that he previously did not understand.

Another interaction involved the fundamentals of a scaled floor plan. Students had to calculate the length and width of portions of the irregular-shaped floor to determine the area of the restaurant space, in order to discover how much carpet they would need. Kristy was confused about the scaled dimensions of the floor plan, and Susan explained to Kristy the general idea of a scaled floor plan.

Kristy What in the heck? Inches equal two feet?

Susan Yes, it's one-half inch equals two feet in real life, seriously.

Kristy Okay, Susan? Equals two feet?

Susan No, so this is [½ inches] on this [floor plan]… this is the way it is.

Kristy was confused as to how inches could equal literal feet. Susan tried to distinguish the two for her by informing her that the one-half inch on the floor plan equals two feet in real life.

When dealing with incorrect information and miscalculations, students were often able to correct one another and help each other gain a better understanding of the content. The following conversation between Susan and Leon exemplifies how group members corrected one another. The group had picked the number of chairs they wanted at their restaurant, and Susan and Leon tried to calculate the cost of the 56 chairs.

Susan No, you got it wrong.

Leon No, 50… 60, 60 times...

Susan Look here. Look, here, look, okay.

Leon 60 times seven...

Susan 56. We need 56 chairs.

Leon 56 times $60.

Susan So that equals $3360.

Susan corrected Leon when he miscalculated the cost of the chairs. Leon was able to see his mistake and make the necessary corrections to get to the correct amount.

In the following example, Katie not only corrects Eugene's mistakes, but was also able to provide new insight. Katie and Eugene discussed the number of recipes they would need for a party of 50. They had chosen a six serving size recipe.

Katie Okay. So, if we have...

Eug. ...50 times six.

Katie No. It would be six times what is closest to 50. [Katie began to show her work on paper.]

Eug. I don't think this is right but I got 300 in my head.

Katie 54. Okay. If we did nine... If we cooked nine different ones of these [six serving recipes]...

Eug. Right.

Katie ..we would have enough for 54 people.

Eug. Okay.

Katie quickly disagreed with Eugene's miscalculation. She then let him know what they needed to do instead and began showing her calculations on paper. As Eugene struggled with the multiplication, Katie discovered the number of recipes that they would need and showed Eugene her work. Eugene was then able to see his error.

Challenges

There were a number of challenges encountered during the course of the program. These challenges included inconsistent attendance, grade and maturity level of students, and teacher dependence, all of which had negative effects on the project such as off-task behavior.

Attendance.

The afterschool program at Harris Community Center was structured in a way that students arrived after school and left whenever their parents/guardians came to pick them up. The program did not have a set schedule and parents/guardians would pick students up within a few minutes of or hours of their arrival at the center. Students also had varying schedules, events, or other obligations that prevented them from attending the afterschool program regularly. Due to these dynamics of the afterschool program, student attendance, during the project, was inconsistent. Three out of the eleven participants were present each day; however, of those three students none stayed the full length of the program each day. Therefore, the everyday occurrence of early dismissals and absences prevented some students from grasping all of the concepts, understanding the project components, and creating strong team relationships. These challenges were especially noticed for those who already struggled with many of the concepts and lacked qualities of self-efficacy.

Ryan is an example of a student who had frequent absences. He missed three days in total, including the first two days. His absences prevented him from fully understanding the project, its components, and underlying mathematical concepts, as well as put a damper on his relationship with his teammates. Additionally, he lacked self-efficacy qualities, which often led him to want to give up. Ryan made the following comment to his other group members, Mary and Katie, during his first day back after his first two absences.

Ryan Man, I don't know what to do at all. You all just keep mixing me up.

Ryan was confused about what the project was about and his group members gave him only a vague description of it while they continued to work. In my field notes I remarked:

> Ryan struggled to find his place in the group and got frustrated because he felt his group didn't inform him enough of what they were doing. Instead of trying to discover what to do, he wanted to be told exactly what to do and how to do it.

As Ryan struggled to understand the components of the project, he also had the challenge of finding his place among his group. When Katie and Mary were determining how to set up the furniture on the floor plan, Ryan tried to find out what they were doing and why.

Katie Yes, right. We're going to use that to map out the…

Ryan I don't know what to do. They just keep getting me mixed up.

Mary We're planning a restaurant.

Katie So we got…

Mary We got this.

Katie We got these chairs.

Katie talked with Mary about planning out the furniture set-up on the floor plan. Ryan was still confused about the objectives of the project. Mary quickly tells Ryan that they are planning a restaurant and then she and Katie went back to discussing the chairs they had bought and how to draw them on the floor plan. Several minutes later, Ryan voiced his concern to me about how being absent was preventing him from knowing what was going on.

Ryan I don't get what you all are doing because I wasn't here.

Ms.L Well, ask your group members. They know.

Ryan I did ask them. They said nothing.

I reminded the group that they needed to work together as a team. Later, Ryan tried to ask what he could do in the group.

Ryan Can I do something?

Katie Yes. You can help me figure out if we need… If [they are] cases of 12, and we need 14 tables, how many…

During the course of the day I had to encourage Ryan to stay on task a number of times. In my field notes, I recorded:

"Ryan displays a lot of off-tasks behaviors. I had to redirect him back to his group several times. He said his group wouldn't let him do anything. I told him to get [involved and active] like Mary and Katie."

Once Ryan was able to attend classes on a more consistent basis, he was able to participate more with the group. According to the checklist, by day four, Ryan showed increased signs of problem solving-skills, positive attitudes, and good cooperation.

Another negative effect of fluctuating attendance was a lack of team collaboration, especially among students from different groups who had to work together due to the absences of their group members. Students had a difficult time working with and adjusting to members from other groups. In one situation of combining groups, two members from Group C, Eugene and Edmond, were placed with Katie, whose other three group members were either absent or had left early. The merged group worked on creating the restaurant menu for which they had to find the quantity and cost of ingredients for each menu item. Eugene and Edmond spent most of the time exhibiting off-task behaviors.

Ms. L So, you guys need to come up with a way that everybody is working and not just here to play.

Eug. Right.

Katie I'll go ahead and start doing the chicken, fried chicken.

Ed. I'll kind of finish the chocolate cake.

Ms. L [Eugene] are you going to work with her? Are you going to do...? What are you going to do?

Katie How about Edmond and Eugene work together and figure out how many chocolate chips we need?

Both Edmond and Eugene were not choosing components of the task to complete and had to be reminded to work with Katie. Edmond agreed to work on one of the recipes; however, after a few minutes, Eugene and Edmond were both off task again.

Ms.L You're doing very good but, you know, it's not a one-man job because you see how much work it is.

Katie Right.

Ms.L We need Mary here.

Katie Seriously. But [Mary], she never comes on Fridays. That's why. And we won't be here on Monday and if we do, we're late because we have to go to band.

The task that Katie was in the process of completing was a time-consuming one, which required group collaboration to make it less strenuous. Mary, an absent group member, worked well with Katie and would have been a great help in that process. Katie informed me of why Mary was absent and reasons as to why they both had other absences and tardiness. This scenario truly illustrated how attendance led to a lack of team development. Attendance issues in conjunction with the short duration (one week) of the program prevented students from forming the group dynamics needed to support the type of teamwork essential to a project-based learning setting.

Teacher dependence.

The short duration of the program also prevented students from acclimating to their roles as engaged learners and the teacher's role as a facilitator. In a PBL setting, students are encouraged to be autonomous, active learners who take responsibility for their own learning, and in which there is interdependence, rather than dependence between student and teacher. The teacher is meant to guide students through their discovery. However, as demonstrated by their actions, the majority of the students seemed to be accustomed to teacher-directed classrooms; that is, the teacher has control over student learning. During the project, students regularly sought out teacher support to the point that their instinct was to depend on the teacher to make group decisions.

In two different instances, members from Group B asked for unnecessary assistance from me. The group was working on finding furniture for the restaurant. Their goal was to determine the number of chairs and tables they needed for a grand opening of 50 people. Students had a furniture book to choose and order the necessary items.

Katie Wooden bench? Not bad. I would definitely want to get cappuccino… like, just the color because it looks the nicest. How much is that?

Mary 199.

Katie For…

Mary I don't know.

Katie Here. Let me ask [Ms. Linda] real fast. We have a question. Right here, we want to know how much this booth is and how many we get.

In the above situation, the students asked me to decide how many chairs or booths they would need, instead of working as a group to determine the number that would fit best in the space and budget for the amount of people given. I wrote in my field notes how one student, in particular, was very dependent on me.

> Katie seemed to understand the work, but lacked confidence. Instead of talking information over with her teammates, she came to me and asked several questions about what they should do. My response mostly was to ask [her] teammates, or what [they thought]. The majority of the time Katie ended up answering or discovering the answers to her own questions.

These behaviors illustrated the fact that the majority of the students were familiar with teacher-directed classrooms and had a difficult time adapting to a more student-centered approach in the given time frame

Grade and maturity levels.

The project included students in grades ranging from second to sixth. The material was intended for students in the fourth grade and beyond. Those students in the second and third grade struggled with the project content and process which led to a number of off-task behaviors as well as lack of meaningful contributions to the group.

For those students who struggled with the project content, the tasks had to be modified. In my field notes, I recorded the following:

> I had to modify the lessons for Ryan and Jason because their other two group members were absent. The work was geared more toward fourth and fifth graders and Ryan was in the fourth grade and Jason in the third. I had them complete the recipe task without needing to find the exact measurements for each item; instead, they only were asked to purchase the items for each recipe needed. This allowed both Ryan and Jason to actively engage in the material as a group with little to no assistance.

Ryan and Jason were the only members of their group present that day. Although Ryan was in the fourth grade, due to the fact that he had frequent absences he was unfamiliar with the content. In his absence, Ryan missed out on the knowledge base created in which his other two group members, Katie and Mary, had been able to gain, share, and discover information.

The students in Group C were not fully observed the relevant data were not analyzed due to the fact that two of the members were second and third graders, who lacked a great amount of content knowledge to successfully complete the project independently. The third group member, Eugene, was a sixth grader, but according to the checklist, he lacked motivation, and had a difficult time staying focused on the tasks. I made the following comments in my field notes: “The students in group C had to be told several times to stay on task and make sure to follow all the steps in completing the project….The first day group C didn’t get anything accomplished on the [project] checklist.”

Derin and Jason were third graders who also displayed a lack of content knowledge as well as immaturity. They had to be repeatedly told to stay on task by both me and their group members, even though they had knowledgeable group members. In one instance, Susan, Derin, and Jason worked on determining how to situate their furniture.

Ms. L Derin, make sure you’re working on the project up there.

Derin Okay.

Susan She’s just trying to write bubble letters always. Now Derin if you do not get over here and help...

Derin Okay done.

Susan You too Jason. Okay so we know that the top of the tables are 48 inches. The bottom is 36. We are not going to draw on this until we're perfectly sure. Use that, it's bigger. Derin you don't have to...

The above conversation was a reoccurring theme for Derin and Jason. They exhibited a number of off-tasks behaviors throughout the duration of the project.

Conclusion

Despite the challenges, I have found that when students are actively engaged in project-based learning, in an OST setting, they are able to collaborate with one another and the instructor to gain new insights and knowledge that varies from a typical classroom. The aim of this study was to consider the following questions:

1. In the context of mathematics, how do the conceptual understandings and problem-solving skills of fourth and fifth graders develop through PBL in an OST setting?, and
2. How do students' attitudes toward mathematics change after participating in PBL in an OST setting?

To address the first question the checklists, recordings, small group discussion, field notes, and pre- and post-assessment were analyzed. The pre and post-assessments did not show any development of conceptual understandings and problem-solving skills. The students' performance remained consistent from the pre- to post-assessments. The short duration of the project was determined to have been a main factor as to why no change occurred. However, the students did demonstrate understanding while actively engaged in the project despite the results on the assessments. For example, Susan was able to find the area of her space and was then able to share with others how she found her answer. Nevertheless, Susan missed the post-assessment question pertaining to finding the area of a given space with measurements. Krajcik et al. (1998)

studied a project-based learning science program in which students learned through inquiry. Their results led them to conclude that expected growth is not smooth, uniform, or linear but with appropriate assistance, students should be able to make significant progress. These findings align with the outcomes of this study as well.

In his writings, Vavilis (2003) states that students learn through social interactions with teachers, their peers, and the environment. Throughout the project, students collaborated to learn from each other as well as teach each other. The prior knowledge that students brought to their groups helped others to develop conceptual understandings. Students were also able to discover answers for themselves and were then able to convey that knowledge to others. If miscalculations or misinformation was given they often corrected one another. The sharing and gaining of knowledge allowed students themselves to become coaches and facilitators. In times of confusion, students were guided through scaffolding, by the teacher, to aid them in understanding the variety of concepts with which they struggled. Although there were moments in which students were able to demonstrate self- and group-guided discoveries, there were several instances in which students struggled with teacher dependence. They wanted me to make a number of group decisions and to teach them rather than support them as a facilitator. These occurrences showed the learned behavior that students acquired from a teacher-directed classroom, in which students are taught what to do instead of engaging in discovery-based activities.

Due to the novelty of the instructional approach, the students had to overcome a number of hurdles to complete the project. There were feelings of frustration and helplessness that had an effect on students' attitudes. However, students who were persistent, confident and enthusiastic were able to overcome these obstacles. Despite any negative attitudes toward mathematics or the project, students understood the great opportunity that the project offered. One student noted that the mathematics was more challenging than what she had experienced in the classroom, but once one was able to acclimate to the new way of learning, she was able to handle the challenges.

The experiences students had during the project varied greatly from what they did in their classrooms. Two students discussed how the project was more than regurgitating facts and following procedures like they normally do in a classroom, instead the project required them to create and engage in real-world experiences. Another student commented on how the project was more entertaining than his classroom experience. There was some discrepancy in terms of whether students liked mathematics. In the post-survey, four of the six students stated that they liked mathematics; however, during the group discussion held at the end of the project, some of the same students stated that they did not like mathematics. These contradictions made it difficult to draw conclusions based upon students' perception of mathematics.

Overall, the results from this study show that students' active engagement and social interaction with peers and the instructor, allowed them to acquire new knowledge (Barron et al., 1998; Blumenfeld et al., 1991; Heyl, 2008; Phillips, 1998; Vavilis, 2003; Vygotsky 1978). Furthermore, interaction with the project helped students gain new experiences that differed from what they would learn in a regular classroom setting.

Recommendations

As previously discussed, challenges were encountered during the implementation of the project. These difficulties were due to two major limitations of the study, namely the duration of the project and the small sample size. Since the project was only one week in length, students had difficulty adjusting to *the norms* of project-based learning, such as working collaboratively to solve open-ended tasks. Additionally, the students were still trying to form working relationships with each other and me as the project came to a close. Although the sample size was small and the findings are not generalizable, based on my experiences, I have the following recommendations for those who are considering implementing project based learning in an OST setting. In addition to having a well-developed project-based curriculum with resources, I suggest the following components: a long-term program, consistent program time, and instructor professional development.

- To effectively implement a project-based program in an OST setting, the program needs to occur over an extended amount of time. This will allow for students to gain deeper relationships with one another, which will aid in group collaboration. For those students who are not accustomed to being actively engaged, social learners, a prolonged experience will enable them to acclimate to the norms of project-based learning. Students will also be able to show significant amounts of growth by spending more time involved with the content.
- A project-based learning program should provide an allotted time that students are required to stay. This will alleviate the issue of students leaving early or having a great number of absences, which in turn will help with relationship building as well as conceptual understandings.
- Instructors need professional development in which they acquire knowledge on how to be a facilitator or coach in the learning process. An essential component of these experiences is strategies for helping students transition from teacher-directed instruction to student-centered instruction in which students will be learn how to be facilitators of their own learning as well as how to aid others. These sessions should also include

information that helps instructors stay up-to-date on the current research and allow for collaboration and sharing of experiences and knowledge with one another. Instructors need to be made aware of the best practices and how to implement them so that they will be ideal facilitators in a project based learning setting.

Previous research has identified critical components of project-based learning including projects as the curriculum, clear and appropriate goals, student-centered, authentic experiences and on-going assessment (Barron et al., 1998; Blumenfeld et al, 1991; Lauer et al., 2004; Seidel et al., 2002; Tal et al., 2006; Thomas, 2000). However, due to the unique circumstances of out-of school settings, additional factors need to be considered. Taking into account the aforementioned recommendations, further research needs to be done to establish the components for an effective implementation of project-based learning in an OST setting. Upon successful integration of PBL in an OST, studies can then be conducted to evaluate classroom performance in conjunction with a PBL experience. With refinement, a project-based learning program in an out-of-school setting has the potential to supplement learning, enabling students to be more successful in the classroom.

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Appendix A
Pre/Post Mathematics Perception Survey

Mathematics Survey

On a scale from 1-5 rate how much you like math?

Not at all Kind of A lot

1 2 3 4 5

Check the box that you agree with most and finish the sentence.
[ ] I like math because ____

[ ] I dislike math because____

1. How often do you get frustrated when doing math?
☐ Always
☐ Sometimes
☐ Never

2. How often do you think math is fun?
☐ Always
☐ Sometimes
☐ Never

2. How often do you struggle with solving word problems?
☐ Always
☐ Sometimes
☐ Never

4. If you get stuck on a math problem on the first try, do you usually try to figure out a different way that works?
☐ Always
☐ Sometimes
☐ Never

5. How often do you use what you have learned in math outside of school?
☐ Always
☐ Sometimes
☐ Never

6. What is your favorite school subject? ______________________________

7. Why is it your favorite subject? __________________________________

Appendix B
Pre-Assessment

Name____________________________________

Use >, <, or = to compare the following fractions. Show your work.

1) $\frac{1}{2}$ ◯ $\frac{2}{3}$

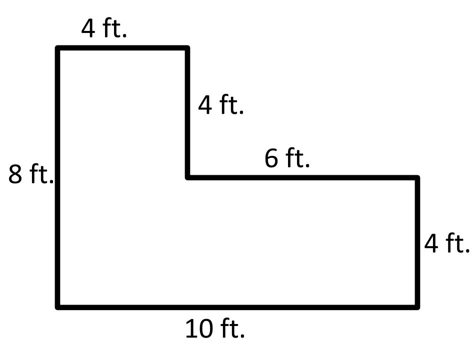
2) $\frac{1}{4}$ ◯ $\frac{5}{6}$

Write two **equivalent fractions** for the following fractions. Show your work.

3) $\frac{1}{2}$

4) $\frac{1}{4}$

5) Find the area and perimeter of the figure below. Show your work.



Area:________ Perimeter___________

Solve.

6) A recipe calls for $\frac{2}{3}$ cup of white flour and $\frac{1}{4}$ cup of whole wheat flour. How much flour do I need in total for the recipe? Explain.

7) Mr. Helms needs to cover a floor that is 10ft. by 9ft. with carpet. If the carpet costs $2 per square feet how much will it cost to cover the entire floor with the carpet? Show your work.

8) A gingerbread cookie recipe that makes 40 cookies calls for $4\frac{1}{2}$ cups of flour. If you need to increase the recipe in order for it to yield 5 dozen cookies, how much more flour will you need? Show your work.

Appendix C
Post-Assessment

Name____

Use >, <, or = to compare the following fractions. Show your work.

2) $\frac{2}{3}$ ◯ $\frac{2}{6}$

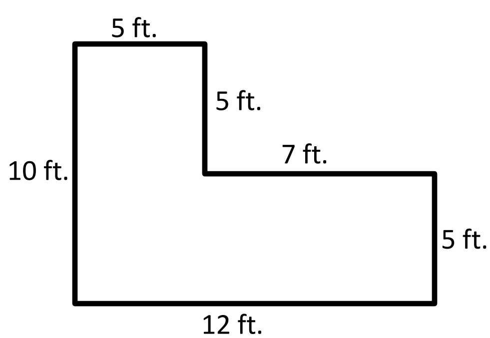
2) $\frac{1}{8}$ ◯ $\frac{3}{4}$

Write two **equivalent fractions** for the following fractions. Show your work.

3) $\frac{1}{3}$

4) $\frac{1}{5}$

5) Find the area and perimeter of the figure below. Show your work.



Area:________ Perimeter___________

Solve.

6) A recipe calls for $\frac{1}{2}$ cup of white flour and $\frac{2}{3}$ cup of whole wheat flour. How much flour do I need in total for the recipe? Explain.

7) Mr. Helms needs to cover a floor that is 12ft. by 6ft. with carpet. If the carpet costs $3 per square feet how much will it cost to cover the entire floor with carpet? Show your work.

8) A gingerbread cookie recipe that makes 60 cookies calls for $2\ \frac{3}{4}$ cups of flour. If you need to increase the recipe in order for it to yield $7\frac{1}{2}$ dozen cookies, how much more flour will you need? Show your work.

Appendix D
Checklist

Student Names

1. Understands problem											
2. Finds useful strategies											
3. Explains results in writing											
4. Explains results orally											
5. Uses models											
6. Organizes data											
7. Justifies solution											
8. Uses logic in arguments											
9. Finds relationships											
10. Remains on task											
11. Is confident											
12. Works cooperatively											
13. Is persistent											
14. Shows enthusiasm											
15. Supports group members											
16. Shares ideas with others											

Adapted from: Muschla, J. A., & Muschla G. R. (2009). Evaluating Math Projects. *Hands-On Math Projects with Real-Life Application, Grades 3-5* (p. 37). San Francisco, CA: Jossey-Bass.

Appendix E
Lesson Plan

FLOOR PLAN

NCTM Standards

- understand such attributes as length, area, weight, volume, and size of angle and select the appropriate type of unit for measuring each attribute;
- understand the need for measuring with standard units and become familiar with standard units in the customary and metric systems;
- develop strategies for estimating the perimeters, areas, and volumes of irregular shapes;
- select and apply appropriate standard units and tools to measure length, area, volume, weight, time, temperature, and the size of angles;
- develop, understand, and use formulas to find the area of rectangles
- carry out simple unit conversions, such as from centimeters to meters, within a system of measurement;
- select appropriate methods and tools for computing with whole numbers from among mental computation, estimation, calculators, and paper and pencil according to the context and nature of the computation and use the selected method or tools.

Objectives

- Create a scale model
- Measure length, width, and area
- Convert various measurements
- Choose appropriate computations and tools to solve problems

Materials

- Grid paper
- Floor plan examples
- Furniture Catalogs
- Computer
- Ruler

Essential Questions

1. How do you find the area of a given region?
2. What are efficient ways to count a large number of objects?

Day 1

1. Inform students that they will be given the opportunity to create their own dining area and food items for a restaurant.
2. Inform students of all that will be involved in the project and give them their budget.
3. Briefly discuss scale models with examples
4. Allow students to break up into groups to explore floor plans and decide on a floor plan for their restaurant.
5. Have students create a scaled floor plan using graph paper.
6. Students will need to determine how much carpet they need for their space and how

much it will cost.

Journal: How did you find the area of your space? What do you have questions about?

Day 2

1. Groups will determine how many chairs, tables, and/or booths they want in their restaurant
2. Have groups look through catalogs to find and record items they want for their restaurants
3. Have groups draw the items onto the scaled floor plan

Journal: Describe how you felt when working on this part of the project.
Journal: Today I discovered that…

Day 3

1. Use the online program floorplanner.com to create a computerized version of the floor plan.

Journal: Make a list of tips you would give to someone when designing a floor plan.

Menu Items & Recipes

NCTM Standards

- develop understanding of fractions as parts of unit wholes, as parts of a collection, as locations on number lines, and as divisions of whole numbers;
- use models, benchmarks, and equivalent forms to judge the size of fractions;
- understand various meanings of multiplication and division;
- understand the effects of multiplying and dividing whole numbers;
- identify and use relationships between operations, such as division as the inverse of multiplication, to solve problems

Objectives	Materials
• Multiply and Divide whole numbers and/or fractions • Accurately maintain a ledger for a budget	• Recipes • Computer • Calculator

Essential Question

1. How do you duplicate recipes?

Day 4

1. Students will look through a number of recipes and decide what they want as appetizers, entrees, drinks, and desserts
2. Students will decide how to make enough food for 50 guests based off of serving sizes of

recipes chosen.

3. Each group will need to make a complete grocery list and budget for their menu.

Journal: What did you learn today?

Journal: What does it mean to multiply? What does it mean to divide? Give an example of each.

Day 5

1. Groups will design their menu using Microsoft Publisher

Journal: Write other ways in which menus from restaurants can involve math.

Appendix F
Whole Group Discussion

1. What are your thoughts on this project?
2. How was this project different from what you normally do in a mathematics class?
3. What did you like most?
4. What did you like least?
5. Has your view of mathematics changed? Explain.

Appendix G
Parent Permission Document

Texas Christian University
Fort Worth, Texas

PARENT'S PERMISSION TO PARTICIPATE IN RESEARCH

Title of Research: Integrating Project Based Learning into an Out-of-School Time setting to Enhance Students' Experiences with Mathematic and their Understanding of Mathematical Concepts

Funding Agency/Sponsor: None

Study Investigators: Susan Freemon and Linda Blue

What is the purpose of the research? The purpose of this study is to examine your child's understanding, problem solving skills, and perceptions of mathematics through the use of project-based learning. Proect-based learning is hands-on and student-centered.

How many children will take part in this study? 8 to 10 children will participate in this study.

What is my and my child's involvement for taking part in this study?
Your child will first complete a pre-assessment to determine their level of understanding of the mathematical concepts that will be presented throughout the project. They will also be given a pre-survey that will rate their perception of mathematics.

Next, your child will be placed in a small group and participate in a program that incorporates a project based curriculum. Your child will be asked to participate in all the activities and be responsible for keeping a daily mathematics journal. Your child's interactions with the other students will be audio recorded during these small group sessions.

Once the project is complete, your child will participate in a small group discussion as well as complete a post-assessment and post-survey.

For how long is my child expected to be in this study, and how much of my child's time is required? The project will last for seven days. During this week, the students will meet for one and a half hours each day. In total, your child will be spending approximately 12 hours participating in this project. Both the pre- and post-survey should require no more than 10 minutes for your child to complete. Your child will be given an hour to complete both the pre- and post-assessments.

What are the risks of taking part in this study and how will they be minimized? In general, participation in this program will not be any different than engaging in any other activity in the afterschool program at Harris Community Center.

Your child may have a feeling of frustration due to his/her lack of knowledge of some of the mathematics content. The use of scaffolding will be used to reduce this risk. Scaffolding is the ability to build upon students' existing knowledge to assist them in unfamiliar learning situations, and allow them to become familiar with the unknown concepts. Furthermore, your child will be informed that his/her decision to participate in the project will be voluntary and they can elect to withdraw from the study at any point during its implementation.

Your child may also not be familiar with student-centered learning and be more used to teacher-centered instruction. Project-based learning will be explained to your child and opportunities to acclimate to the project-based learning environment will be built into the project.

Also, your child may feel uncomfortable being recorded. They will be informed and reminded to just be themselves and act as if the recorder was not there.

What are the benefits for taking part in the study? By participating in this project your child may have the opportunity to improve his or her problem solving skills, understanding of mathematics concepts, and perceptions of mathematics as well as social skills.

Will I be compensated for taking part in the study? No, you will not be compensated for your child's participation in this study.

What is an alternate procedure(s) that I can choose instead of having my child take part in this study? Your child can attend the regularly scheduled programs offered at the Harris Community Center.

How will my child's confidentiality be protected?
All data and information obtained from this study will remain confidential. Confidentiality will be kept by doing the following:

- Findings will be presented in a summary fashion that will not identify your child.
- Audio recordings will not be played at conferences.
- All documents and data collected will be kept in a locked storage safe.
- Audio recordings will be saved on a flash drive which will be kept securely locked in the storage safe.

Is my child's participation voluntary? Yes, participation is voluntary. Your child can choose not to participant in this study at any time and it will not affect the other services provided at the Harris Community Center.

Can my child stop taking part in this research? Yes, this study is completely voluntary and your child can opt to withdraw from the study at any time without penalty. In this case, your child will still have the opportunity to participate in the project, without being apart of the research study.

What are the procedures for withdrawal? If students wish to withdraw, they can verbally tell Laura Blair at any time during the project. If you would like to withdraw your child from the study you may inform Linda Blue via phone or email.

Will I be given a copy of the permission document to keep? Yes, you will be given a copy of the permission document to keep for your own records.

Who should I contact if I have questions regarding the study? Please contact Linda Blue in person, by phone, or by email.

Who should I contact if I have concerns regarding my child's rights as a study participant?
Dr. Meena Shah, Chair, TCU Institutional Review Board, Telephone 817 257-7665.
Dr. Janis Morey, Director, Sponsored Research, Telephone 817 257-7516.

Your signature below indicates that you have read or been read the information provided above, you have received answers to all of your questions and have been told who to call if you have any more questions, you have freely allowed your child to participate in this research, and you understand that you are not giving up any of your legal rights.

Child's Name (please print): ____________________ Date of birth:_________________

Parent's Name (please print): ____

Parent's Signature: ______________________________ Date:______________

Investigator's Signature: __________________________ Date:______________

Appendix H
Assent Document

Texas Christian University
Fort Worth, Texas

STUDENT ASSENT TO PARTICIPATE IN RESEARCH

Title of Project: A New Way to Experience and Understand Mathematics

Study Investigators: Susan Freemon and Linda Blue

What is the reason for this study? The purpose of this study is to find out if this project can help improve your mathematics skills and how you feel about mathematics, as well as improving how well you work together with others.

How many people will be in this study? 8 to 10 children will participate in this study.

What will I need to do during this study? This project involves participating in hands-on learning experiences, writing in a daily mathematics journal, as well as a couple of small tests, surveys, and a small group discussion.

How long will I be in this study and how much of my time is required? The project will last seven days. During this week, you will meet for one and a half hours each day.

What are the risks of being in this study and how will they be decreased? We do not expect any major problems to happen to you during this study but you might feel frustration from not being familiar with some of the mathematics content. You might also feel frustration during the project because the majority of the work will be led by you and your teammates and will not be directed by the teacher. Linda Blue will help you when needed and help get rid of any frustration that you may have. You will also be audio recorded each day during this project. It might take some time to get used to knowing that you are being recorded.

What good things will I gain from this study? By participating in this study you will have an opportunity to improve your mathematics skills and the way you feel about mathematics.

Will I be paid for being in this study? No, you will not be paid for being in this study.

What else can I do instead of being in this study? You can attend the regularly scheduled programs offered at the Harris Community Center

How will my privacy be protected? All of your information will be kept private and will only be seen by me.

Do I have to participate? You do not have to be in this study if you do not want to. You won't get into any trouble if you choose not to participate.

Can I stop taking part in this research? You may stop being in the study at any time. Your parent(s)/guardian(s) were asked if it is okay for you to be in this study. Even if they say it is okay, it is still your choice whether or not to take part. .

What do I do if I don't want to be in the study anymore? If you wish to stop being in the study, you can tell Linda Blue at any time during the project.

Will I be given a copy of the document to keep? Yes, you will be given a copy of the permission document to keep.

Who should I contact if I have questions about the study? Please contact Linda Blue in person, by phone, or by email.

Who should I contact if I have worries about my rights?
Dr. Meena Shah, Chair, TCU Institutional Review Board, Telephone 817-257-7665.
Dr. Janis Morey, Director, Sponsored Research, Telephone 817-257-7516.

Your signature below indicates that you have read or been read the information provided above, you have received answers to all of your questions and have been told who to call if you have any more questions, you have freely decided to participate in this research, and you understand that you are not giving up any of your legal rights.

Participant Name (please print): ____

Participant Signature: _________________________ Date:_____________

Investigator Name (please print):__________________ Date:_____________

Investigator Signature: ______________________ Date:_____________

VITA

Personal Background	Laura Kathleen Blair Columbus, Georgia
Education	Diploma, Asheville High School, Asheville, North Carolina, 2001 Bachelor of Elementary Education, Pfeiffer University, Misenheimer, 2005 Master of Elementary Education, Texas Christian University, Fort Worth, 2012
Experience	Compliance Substitute, FWISD, Fort Worth, 2011-2012 Tutor, Sylvan Learning Center, Arlington, 2011-2012 Tutor, Guilford County Schools, Greensboro, 2008-2010 Teacher, Guilford County Schools, Greensboro, 2006-2008

ABSTRACT

INTEGRATING PROJECT-BASED LEARNING INTO AN OUT-OF-SCHOOL TIME SETTING TO ENHANCE STUDENTS' EXPERIENCES WITH MATHEMATICS AND THEIR UNDERSTANDING OF MATHEMATICAL CONCEPTS

by Laura Kathleen Blair
College of Education
Texas Christian University

Thesis Project Advisor: Sarah Quebec Fuentes, Assistant Professor of Mathematics Education

Project-Based Learning (PBL), real-world based projects, has been found to increase students' abilities to understand, use and present concepts; allow the use of higher level thinking skills; enhance motivation and attitude; and increase engagement. Due to the lack of time and resources within the classroom, other avenues must be investigated that will allow PBL to be utilized in an effective manner. The use of Out-of-School Time (OST) provides this opportunity as well as assistance to students with needs that extend beyond a regular classroom setting. However, little direct research has been done to determine the effectiveness of project-based curricula in OST settings. This study incorporated a PBL curriculum into an afterschool program. The data collected and analyzed included surveys, assessments, checklists, field notes, audio recordings, student mathematics journals and notebooks, and a group discussion. As a result of the project, students were able to collaborate with one another and the instructor to gain new insights, knowledge, and experiences that varied from a typical classroom. These results, along with recommendations based on the findings, will aid in future implementations of a PBL curriculum in an OST setting. With refinement, a PBL program in an OST setting has the potential to supplement learning, enabling students to be more successful in the classroom.