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PROJECT BASED LEARNING IN URBAN PUBLIC SCHOOL EDUCATION AND ITS IMPACT ON ACADEMIC ACHIEVEMENT AND SCHOOL ENVIRONMENT

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ABSTRACT

PROJECT BASED LEARNING IN URBAN PUBLIC SCHOOL EDUCATION AND ITS IMPACT ON ACADEMIC ACHIEVEMENT AND SCHOOL ENVIRONMENT

Nayeon Naomi Hwang

Thinking creatively and critically, demonstrating effective problem-solving skills, and communicating powerfully and compellingly to a wide range of audiences, are undoubtedly some of the most important skills necessary for success in our global society. The purpose of this study is to explore the connection between the development of students' creativity and problem-solving skills to academic achievement. This study examines schools that emphasize the development of students' problem-solving skills by employing project-based learning (PBL) as a core method of instruction, and its impact on students' academic achievement in English Language Arts and in mathematics. This study also examines the impact of the different methods of instruction on the school environment, which can be one of the most important factors affecting student learning.

The target population for this quantitative study are 4th and 8th grade students in an urban public-school system receiving instruction, either primarily through a traditional method of instruction or through instruction employing the project-based learning method. In the study, the results of The New York State Grade 4 and Grade 8 English Language Arts Test and the New York State Mathematics Test, reflecting students' academic achievement, from all 50 elementary schools (19 PBL, 31 traditional) and 22 middle

schools (12 PBL, 10 traditional) in two NYC districts were analyzed. Findings from this study revealed that there were statistically significant differences on both the NYS ELA Test and the NYS Math Test between the two groups (PBL vs. traditional) for both 4th grade and 8th grade students. To examine the impact of the different instructional approaches on the school environment, results of the NYC School Survey data on subareas of Rigorous Instruction and School Environment were analyzed. Findings from this analysis revealed that there was a statistically significant correlation between the instructional approach employed and the Quality of Student Discussion. Moreover, there was statistically significant correlation between the instructional approach employed and Supportive Environment of High Expectations. The results from this study provides an exciting illustration of a strong positive correlation between PBL, an instruction approach that focuses on the development of students' creativity and problem-solving skills, and academic achievement.

DEDICATION

I dedicate this dissertation to my late dad who was a constant and an unwavering supporter. He would have been so proud. I miss you.

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My husband and children are my cheerleaders, my source of strength, and hope. Many thanks to my family to supported me throughout the process with much grace and love.

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CHAPTER 1

Introduction

Purpose of the Study

Countless scholars have emphasized creativity and problem-solving skills as an important attributor to one's success. Perkins (2004) sums up these skills as the *knowledge arts,* which "include communicating strategically, insightfully, and effectively; thinking critically and creatively; and putting school knowledge to work in what educators sometimes humbly call the real world" (p. 242). Therefore, educational researchers and practitioners have long emphasized the importance of developing students' creativity and problem-solving skills in our schools. However, a closer look at the education of our K-12 schools provide a different picture, where much of the content is taught in isolation, emphasizing students' factual and procedural knowledge. This misalignment that exists between the instructional practices in most of our schools to intended performance outcomes hinders our children from performing at globally competitive levels. According to research conducted by National Center for Education Statistics (NCES) in 2003, "U.S. performance in mathematics literacy and problem solving was lower than the average performance for most OECD countries" (p. iii). Moreover, NCES also found that "The U.S. score was below the OECD average science literacy score in 2003, (marking) no measurable change in the U.S. science literacy score from 2000 to 2003" (p. iv). Sadly, the state of our education is also contributing to the growing disparity between performance outcomes of low-income communities to middle-high income communities. The study conducted by NCES also showed that only "a few countries showed stronger relationships between socioeconomic background and student

performance than the United States, while more showed weaker relationships" (p. iv). Adding to the concern raised above, according to research conducted by NCES in 2003, the achievement gap between different ethnic groups continue to persist in United States despite our on-going educational reforms:

> In the United States in PISA 2003, Blacks and Hispanics scored lower on average than Whites, Asians, and students of more than one race in mathematics literacy and problem solving. Hispanic students, in turn, outscored Black students. In both mathematics literacy and problem solving, the average scores for Blacks and Hispanics were below the OECD average scores, while scores for Whites were above the OECD average scores. (NCES, 2003, p. iv)

This gap between ethnic groups is even more profound in urban settings.

As Perkins (2004) explains, "education is not just about acquiring knowledge, but also about learning how to do significant things with what you know" (p. 246). Despite this understanding, however, most of our schools are still employing instructional approaches that emphasize factual and procedural knowledge, reminiscent of education prominent during the times of Industrial Revolution. Alternatively, some of our schools have begun to explore project-based learning, a dynamic instructional method in which students explore and solve real-world problems and/or challenges over time.

In this study, the influence of instructional approach that emphasizes the development of students' creativity and problem-solving skills on academic achievement is explored. This study examines schools that emphasize the development of students' problem-solving skills by employing project-based learning (PBL) as a core method of instruction, and its impact on students' academic achievement in English Language Arts and in mathematics. A negative academic impact is expected from a traditional

instructional approach that stress factual and procedural knowledge. Alternatively, a positive academic impact is expected from the PBL instructional approach, which can be key to closing the achievement gap that exist in our urban communities. This study also examines the impact that the different instructional approaches have on the school environment where the sense of high expectations is established. The impact that the different instructional approaches have on the classroom culture of learning where students contribute to a high level of discourse and collaboration with one another is also investigated. To address this issue, Critical Race Theory (CRT) is explored in this study as a theoretical framework for understanding the lasting impact that different approaches to teaching and learning have on students of color in urban communities. By incorporating CRT in the discussion, I hope to make a case for our education system to reexamine our current instructional practices to include deliberate efforts in utilizing instructional approaches such as PBL, which started as a practice in medical schools. Gifted education has adopted its practice and utilized it since 1970's. Dynamic approaches to teaching, such as PBL, could likewise challenge and support all children in acquiring important 21st century skills, regardless of their cultural and racial backgrounds.

Through this study, I do not hope to make a narrow case for project-based learning, but to make a larger case for our education system to reexamine our current instructional practices to include deliberate effort in developing students' creativity, critical thinking, problem-solving, and communication skills critical for our children's success in the 21st century.

Theoretical/Conceptual Framework

While scholars have long agreed on the importance of supporting students' creativity and problem-solving skills, not all scholars, have agreed upon one single definition. Beghetto (2017) argues that "One way to think of creativity is constrained originality. This means that originality is constrained by the need to meet task constraints, to be meaningful, and to be useful" (p. 269). In other words, creativity and originality would be void of any real meaning if it does not lead us to practical solutions to complex problems we face in our world. Beghetto (2013) offers an alternate definition of 'creativity' that researchers generally agree on: Creativity is the combination of originality, novelty, or newness and usefulness, meaningfulness, value, or meeting task constraints as defined within a particular context (Beghetto, 2013; Plucker et al., 2004).

Providing further insights into this topic, Amabile (1983) proposes that the line between creative performance and ordinary performance is not actually so distinct. She states, "Instead of a dichotomy, there is a continuum ranging from performances marked by reliance on entirely familiar algorithms applied by rote, at the one end, to performances marked by the application of set-breaking heuristics and the exploration of completely new cognitive pathways, at the other end" (p. 372). This statement clarifies the misconception people often have about creativity. Oftentimes, creativity is perceived to be a special skill or talent belonging to a few talented individuals. Likewise, creative tasks are often perceived to be artistic tasks that differ from our ordinary routine. However, Amabile (1983) here asserts that creativity can be found within a continuum. What then, does this mean for teaching of creativity and problem-solving skills? Amabile (1983) implies that our pathway to teaching creativity is not something that stands on its

own as a separate and different kind of teaching or lesson. Rather, our teaching practice could range from tasks "marked by reliance on entirely familiar algorithms applied by rote" to teaching practice that are marked by tasks that encourage the "application of set-breaking heuristics", which promote cognitive challenge and creativity as children find new cognitive pathways.

Finding new cognitive pathways and applying them in real-life situations require social interactions between peers where collaborative learning naturally takes place. According to the social constructivist theory, social interaction is an integral part of learning. Vygotsky's (1962) theory posits that social interaction precedes cognitive development and that our cognition is merely an end product, resulting from social behaviors and interactions that take place in a learning environment. Vygotsky (1978) states that "Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological)" (p. 57). The role of the learner is active in that learning is a reciprocal process between all constituents in the classroom. Therefore, developing a classroom environment that promotes high expectations and positive interactions amongst peers and adults is crucial to attaining effective classrooms.

In looking specifically at teacher-student relationships within the classroom, as it relates to the learning environment, Rosenthal and Jacobsen (1968) posits that teachers' expectations in the classroom strongly influence students' academic and intellectual growth. In their study where teachers were led to believe that the certain students who were selected at random to be showing signs of intellectual growth spurts, they found that these students whom the teachers had expectations of intellectual growth spurts showed

significantly greater academic gains compared to the control group. They explain that the result is likely the result of the Pygmalion phenomenon where teachers' expectations act as a self-fulfilling prophesy. High expectations of students, therefore, impact the quality of teacher-student interactions, leading to increase in students' performance and academic outcomes.

Creating a learning environment where teachers deliver quality instruction reflecting high expectations, and where learners collaborate, engage one another in thoughtful discussions, and provide/receive feedback, is therefore critical to the development of students' creativity and problem-solving skills. Vygotsky (1962) also describes scaffolding in his theory and claims that children learn more effectively when they have others, which include peers, to support them. He coined the term, cooperative learning, in his research to describe learning that takes place in such social contexts. Current research points to a strong correlation between the development of social skills and academic achievement, supporting Vygotsky's previous assertions. Tullis and Goldstone (2020) explains, "In peer instruction, instructors pose a challenging question to students, students answer the question individually, students work with a partner in the class to discuss their answers, and finally students answer the question again. A large body of evidence shows that peer instruction benefits student learning (p. 1). They further explain that through student discussions, students are provided with opportunities to verbalize their ideas, which further facilitates new ideas from forming. In addition, the benefits of student discussions also include having more intellectual and information processing resources (compared to an individual) to tackle more complex problems. This type of social learning environment can be more motivating and may challenge students

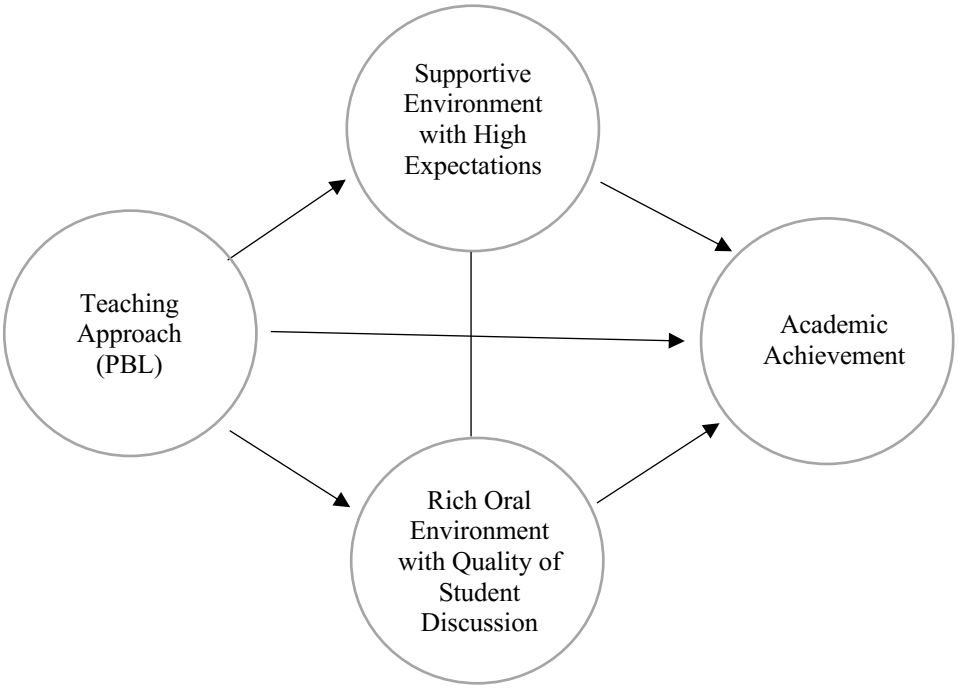
to derive novel ideas or novel representations of established ideas (Tullis & Goldstone, 2020; Schwartz, 1995). Tullis and Goldstone (2020) states, "Learning through peer instruction may involve deep processing as peers actively challenge each other, and this deep processing may effectively support long term retention" (p. 10). Vygotsky's (1962) theory, supported by Tullis & Goldstone's (2020) study, not only highlights the importance of intentionally creating a safe classroom environment where children learn from one another through quality discussions, but also suggest a possible need for educators to thoughtfully and systematically provide children with authentic opportunities to develop skills necessary to socially interact with one another, which inevitably would lead to *intrapsychological* development and academic achievement.

Similarly, Dewey (1933, 1938) posits that reflective thinking and student discussions are natural components of the learning process. In his experiential learning theory, Dewey (1933, 1938) claims that learning occurs within a social environment where knowledge is constructed through students' active experiences. Contrary to the traditional teaching philosophy where knowledge is seen as information that gets passed down from the teacher to students for use in the students' future, Dewey (1933, 1938) views knowledge as understanding that is co-constructed and re-constructed based on students' past and current experiences in real-life. This theory not only points us to the need to provide students with social opportunities, but also to the need to intentionally create authentic, meaningful, real-life opportunities for students to engage in meaning-making with one another. In other words, quality of instruction not only rests on the content material, but the approach to teaching or the method of instruction and its delivery.

Project Based Learning (PBL) is a method of instruction where "students learn by actively engaging in real-world and personally meaningful projects." (Buck Institute for Education, 2014). In this model, students construct their knowledge by working to investigate and solve an authentic and complex question and/or challenge over an extended period of time with their peers. Ayaz and Söylemez (2015) explain, "The main goals of project studies are to help students to take responsibility for their education, to develop their positive risk taking behaviour, to motivate them to cooperate with others (Bilen, 2002; Korkmaz & Kaptan, 2002; Saban, 2000). With project-based learning (PBL) approach, we aim to gain students scientific skills and parallel to that to increase students' academic achievement" (p. 257). PBL approach, thereby, helps create a learning environment with high expectations where students are expected to take ownership of their own learning in which communication and collaboration skills are critical to the learning process. In this model, creating a safe learning environment where students can take risks and learn to co-construct and re-construct meaning with one another through collaborative group work and reflection are paramount to students' academic success. The quality of student discussions, therefore, would naturally increase as a byproduct of the PBL approach to teaching and learning, which may serve to further support students' academic achievement.

Figure 1

Model of the Theoretical Framework



Moreover, Snyder and Snyder (2008) posits that "actively engaging students in project-based or collaborative activities can encourage students' critical thinking development if instructors model the thinking process, use effective questioning techniques, and guide students' critical thinking processes" (p. 90). Snyder and Snyder (2008) analyzed the gross disconnect between business education that emphasizes critical thinking & problem solving skills and the actual instructional practices in business education that is fraught with teachers struggling to engage students in critical thinking skills, and students struggling to problem-solve complex, real-world problems (or perhaps not even being provided with the opportunity productively struggle with complex problems). They explain that the answer to this gross disconnect between the instructional goals and the actual practice is in the instructional method and propose the

use of the project-based learning approach to teaching and learning to bridge this gap. According to Snyder and Snyder (2008), "Learning environment that actively engage students in the investigation of information and the application of knowledge will promote students' critical thinking skills…The effort is worth the reward: students who can critically think for themselves and solve real-world problems" (p. 97).

Wang, Zhou, and Chen (2013) claim that creativity involves the "ability to offer new perspectives, generate novel and meaningful ideas, raise new questions, and come up with solutions to ill-defined problems" and that creativity has been viewed as "the ultimate economic resource and as essential for addressing complex individual and societal issues" (p. 2202). They posit that project-based learning (PBL) encompasses two important elements that "can provide conditions of creativity development": solving authentic problems and group work (Wang et al., 2013, p. 2202). In other words, the PBL approach of teaching and learning can effectively nurture students' creativity and problem-solving skills, which is critical to our children's success in the 21st century.

On a different note, through an empirical study inquiring about the connection between culture and learning styles, Joy & Kolb (2008) found that "Culture has a significant effect in deciding a person's preference for abstract conceptualization versus concrete experience" (p. 83). In education today, as we grapple with the disparity that exists between different ethnic groups, many educators are turning to critical race theory (CRT) to frame their thinking and actions to close the achievement gap. Solórzano and Yosso (2015) claim that "critical race theory advances a strategy to foreground and account for the role of race and racism in education and works toward the elimination of racism as part of a larger goal of opposing or eliminating other forms of subordination

based on gender, class, sexual orientation, language, and national origin" (p. 25). CRT theorists and educators look to critical pedagogy as an approach where teachers embrace the existence of a systemic inequality that negatively impact the academic achievement of our minority students and work to provide a more culturally responsive education. In working to close the achievement gap between different ethnic groups, we then need to acknowledge the possible role that culture plays in reinforcing a certain learning style of our students and reflect on whether our teaching method match the needs of our students, especially students who are at a disadvantage. Alternatively, to support our students in developing multiple abilities and intelligences simultaneously, we need to be intentional in our instructional approach. Following Gloria Ladson-Billings (1995, 2001), we need to embrace the tenets of culturally relevant pedagogy and acknowledge the presence of inequity, uphold high expectations for all our students, demonstrate cultural competence, and work to support our culturally diverse students with an asset-driven mindset and a student-centered learning environment. Voronchenko, Klimenko, and Kostina (2015), in their study exploring PBL as a pedagogical approach to cultural tolerance, found that in cooperation and collaboration between people, there was an increase in tolerance for one another. They state, "In collaboration there is deep existential community of people, which is so important in contemporary globalizing society. Tolerance which is taught through project-based learning defines the further choice of cooperation strategies, respect for dissent instances, understanding different social phenomena. Thus, project-based learning generates not only professional competencies, but tolerant culture of a person who will be ready to positively change the world community" (p. 1494) Project-based learning, which naturally and intentionally fosters an environment of high

expectation, collaboration, and rich student discussions may, therefore, also serve as method of instruction that support students with various learning styles and cultural experiences, as well as an avenue to help build tolerance for one another in our world today.

Significance/Importance of the Research

According to research conducted by National Center for Education Statistics (NCES) in 2003, "U.S. performance in *mathematics literacy* and *problem solving* was lower than the average performance for most OECD countries" (p. iii). If we are to prepare our children to be competitive in the global world, it is critical that we reflect on the current instructional practices prevalent in our public schools today and make a concerted effort to make significant improvements. Educators can no longer be satisfied with merely covering content material. Rather, we must go deeper in each content area by providing students with regular and more frequent opportunities for quality student discussions. Providing students with opportunities to engage with one another on more long-term collaborative projects will also increase opportunities for students to use their creativity to come up with new solutions. More innovative approaches to teaching and learning, such as project-based learning (PBL), may provide students with the opportunity to utilize their knowledge of the specific content area, as well as their creativity and problem-solving skills, to draw out new solutions within the confines of the context and/or environment. PBL may also impact the school and classroom learning environment positively, thereby producing an increase in students' academic achievement. Finding new, dynamic approaches to teaching, such as PBL, that is more relevant to our children's world today and finding new pathways to reach students of

color, who continue to combat multiple layers of disadvantages, is critical to closing the achievement gap that is so persistent in our society. This study examines schools that emphasize the development of students' problem-solving skills by employing project-based learning (PBL) as a core method of instruction, and its impact on students' academic achievement in English Language Arts and in mathematics. This study also examines the impact of the different methods of instruction on the school environment, which can be one of the most important factors affecting student learning.

Research Questions

Again, the purpose of this study is to explore the connection between the instructional approach for developing students' creativity and problem-solving skills and academic achievement by comparing students' achievement on the 4th and 8th grade NYS ELA and Math Test between schools that employ project-based learning approach as the core method of instruction versus schools which employ traditional instruction approach. Students' data on the 4th and 8th grade NYS ELA and Math Test were also compared between PBL schools currently at a lower level of PBL implementation versus PBL schools at a higher level of PBL implementation based on PBL School Rubric by Buck Institute for Education. In addition, the result of the NYC School Survey in the sub-categories, Rigorous Instruction: Quality of Student Discussions and Supportive Environment: Social-emotional, was analyzed to explore any correlations that exist between the different instructional approaches (PBL vs. traditional) on the school environment, which undoubtedly is one of the most important factors affecting student learning.

Research questions.

The following research questions and hypothesis were at the heart of this study:

1. Will there be significant differences in students' achievement on the 4th and 8th grade NYS ELA Test between schools that employed PBL approach and schools that employed traditional teaching approach?
2. Will there be significant differences in students' achievement on the 4th and 8th grade NYS Mathematics Test between schools that employed PBL approach and schools that employed traditional teaching approach?
3. Will there be significant differences in the subcategories of the NYC School Survey, Quality of Student Discussion & Supportive Environment with High Expectations, between schools that employed PBL teaching approach and schools that employed traditional teaching approach?
4. Which predictors, teaching method (PBL vs. traditional), supportive environment of high expectations, and quality of student discussion, predict students' achievement in ELA and Mathematics significantly?

Definition of Terms

For the purpose of this study, the following operational definitions were used:

Project-based learning (PBL): "A teaching method in which students gain knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge" (Bucks Institute for Education, 2014, para. 1). Seven essential project design elements, according to Bucks Institute for Education (2014) are the following:

1. **A challenging problem or question**: The project is framed by a meaningful problem to be solved or a question to answer, at the appropriate level of challenge.
2. **Sustained inquiry:** Students engage in a rigorous, extended process of posing questions, finding resources, and applying information.
3. **Authenticity:** The project involves real-world context, tasks and tools, quality standards, or impact, or the project speaks to personal concerns, interests, and issues in the students' lives.
4. **Student voice and choice:** Students make some decisions about the project, including how they work and what they create.
5. **Reflection:** Students and teachers reflect on the learning, he effectiveness of their inquiry and project activities, the quality of student work, and obstacles that arise and strategies for overcoming them.
6. **Critique and revision:** Students give, receive, and apply feedback to improve their process and products.
7. **Public product:** Students make their project work public by explaining, displaying and/or presenting it to audiences beyond the classroom. ("Gold Standard PBL").

To operationalize the level of PBL implementation, PBL School Rubric from Buck Institute for Education was used. Superintendents and/or Deputy Superintendents in two urban districts were asked to carefully evaluate each of their schools on the level of PBL implementation using the PBL School Rubric. For the purposes of this study, traditional schools, as well as beginning PBL schools in "Significant Content "and "21st Century Competencies", were coded as level 1. In the category of Significant Content, school leaders of a Beginning PBL School is characterized to have a general vision for implementing PBL in the school but may have not yet established a PBL implementation plan to clarify the vision, goals, nor a plan for sustainability. In a level 1 school, some teachers may be beginning to implement PBL, but may still be developing an awareness of the elements of a quality PBL design. In the category of 21st Century Competencies, a Beginning PBL School is characterized by few opportunities for teachers to demonstrate a focus on the 4 C's: communication, collaboration, critical thinking, and creativity. Moreover, in a Level 1 school, school leadership does not explicitly promote and model

the use of the 4 C's. Next, PBL schools that have implemented PBL with some success, but has some areas for growth were coded as level 2. In these schools, school leaders have developed a PBL implementation plan, but some stakeholders may still lack some understanding of the plan and the way in which PBL and other school initiatives are mutually supportive of one another. Level 2 schools are characterized by most teachers having the knowledge of the elements that support a quality project design (Significant Content). In the category of 21st Century Competencies, schools coded as level 2 have school leadership who are beginning to promote and model the use of the 4C's and teachers who demonstrate the use of 4 C's with some inconsistency. Lastly, PBL schools that have achieved full implementation of PBL features were coded as level 3. In these schools, school leaders have established a culture and pedagogical practice that support PBL across the school. In the category of Significant Content, schools in level 3 have school leadership that has developed a PBL Implementation Plan to achieve the vision, goals, and plans for sustainability of PBL. In these schools, PBL is the method of instruction in all of the targeted content areas as defined in the implementation plan. In the category of 21st Century Competency, school leadership is both explicit and consistent in promoting and modeling the use of 4 C's. In level 3 schools, teachers likewise demonstrate the use of 4 C's in their practice. (Bucks Institute for Education, 2014, "A Must Have Rubric for Effective Implementation of PBL in Your School").

Academic Achievement in ELA: ELA achievement scores of each school was operationally defined by the combined percentage of all 4th or 8th grade students in the school achieving at levels 3 or 4 on the New York State ELA Test from 2018-19 school year.

Academic Achievement in Math: Mathematics achievement scores of each school was operationally defined by the combined percentage of all 4th or 8th grade students in the school achieving at levels 3 or 4 on the New York State Mathematics Test from 2018-19 school year.

School Environment: School environment was operationally defined by the scores on the NYC School Survey in Rigorous Instruction and Supportive Environment. Rigorous Instruction is further broken down in to 5 sub-categories: Academic Press, Common Core Shifts in Literacy, Common Core Shifts in Math, Course Clarity, and Quality of Student Discussion. Supportive Environment is further broken down into 7 sub-categories: Classroom Behavior, Guidance, Peer Support for Academic Work, Personal Attention and Support, Safety, Social-Emotional, and Preventing Bullying. For the purposes of this study, School Environment was defined by analyzing two subcategories of the NYC School Survey: Quality of Student Discussion and Social-Emotional.

Supportive Environment with High Expectations: Supportive Environment with High Expectations was defined operationally by the score derived from the percentage of teachers providing positive responses in the sub-subcategory of Social-Emotional under Supportive Environment. To provide clarity, the category was revised as "Supportive Environment with High Expectations" to reflect the content of the questions asked in this section of the survey.

Rich Oral Environment with Quality of Student Discussion: Rich Oral Environment with Quality of Student Discussion was defined operationally by the score derived from the percentage of teachers providing positive responses in the sub-subcategory of Quality of Student Discussion under Rigorous Instruction. To provide

clarity, the category was revised as “Rich Oral Environment with Quality of Student Discussion” to reflect the content of the questions asked in this section of the survey.

CHAPTER 2

Review of Related Literature

Introduction

Project-based learning (PBL) is "A teaching method in which students gain knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge" (Bucks Institute for Education, 2014, para. 1). Seven essential elements of PBL include: a challenging problem or question, sustained inquiry, authenticity, student voice and choice, reflection, critique and revision, and public product" (Bucks Institute for Education, 2014, "Gold Standard PBL"). This chapter reviews literature on several themes emerging from theoretical framework and related studies: project-based learning and its impact on the learning environment, project-based learning and its impact on academic achievement, and the connection between project-based learning and culturally relevant pedagogy.

Project-based Learning and its Impact on the Learning Environment

Learning environment that promotes creativity and problem-solving skills.

In studying creativity and problem solving in relation to the larger systems beyond the classroom setting, Csikszentmihalyi (1989) posits that "We cannot study creativity by isolating individuals and their works from the social and historical milieu in which their actions are carried out." (p. 325). This is because what we deem to be creative is not an individual act, but the product of three interconnected forces: *field, domain* and *individual*. The *field*, "a set of social institutions", make selections of ideas that may be worth preserving. The *domain*, "a stable culture", will preserve and pass

down the selected idea or product that was deemed to have high worth, and the *individual*, who actually brings about the creative ideas that impact change in the domain (p. 325). This theory leads us to several implications when thinking about how we might provide a safe environment for our students to develop courage of taking risks of failure and become more creative.

With the understanding that the creative process is a dynamic process that gets negotiated between the field, domain, and individuals, the learning environment that we provide in schools must reflect that social, communicative process. To promote risk-taking behaviors where ideas can be communicated and negotiated between students and to the larger group, the physical environment should be "workshop-like" where tables are clustered in groups or in stations. In this way, students could collaborate, communicate, test-out ideas with one another in a safer environment. Hands-on materials and tools should be readily available for students to utilize for their learning, and student seating should be flexible, reflecting various groupings and needs. There should be various physical resources, such as reference books, computers, and other technological and digital devices for students to interact with the larger "field" and/or "domain."

The instructional model must also reflect the dynamic process where creativity is derived from the interaction between the three forces: field, domain, and individual. In order to provide an utmost safe environment for our students to develop courage of taking risks of failure, our instructional model needs to provide time for open-ended tasks. One way we might achieve this is by taking an instructional approach, such as project-based learning (PBL). Through this model, teachers can begin with a real-world problem and facilitate students' learning in a way where students can collaborate to find a solution to

the problem. Risk-taking behavior in this model would be encouraged as students test out one prototype after another. Another way we might achieve this is through investigative learning in subject areas, such as mathematics and science. Instead of rote teaching of content, teachers might present the materials for students to investigate a problem to figure out solutions.

A famous saying, "Give a man a fish, and you feed him for a day. Teach a man to fish, and you feed him for a lifetime" illustrates the instructional strategy we need to adopt if we want our students to take risks of failure as they hone-in their creativity. Instead of teaching students one specific method of solving a problem and/or expecting one correct answer to a problem, we need to emphasize the process of learning with equal importance. Our feedback to students or assessment practices must emphasize the process of their learning, rather than correct responses or their final product. In this way, we refrain from limiting students' creativity by validating their attempts at solving a problem. Helping students reflect on the process of their learning could also help students become better problem-solvers, hence encouraging their creativity.

Instructional strategies that promote creativity and problem-solving skills.

There is a strong, multifaceted relationship between creativity, problem solving, and learning. In order to achieve the goal of developing students' problem-solving skills, teachers must first employ creativity to plan their lessons. Approach to instruction where the instructional goal is to develop meaningful and personal understanding in learners will undoubtedly produce long-term benefits to individuals, especially in the fast-paced, competitive global world that we live in today.

What exactly does instruction that help develop students' creativity and problem-solving look like in our classrooms and how can our teachers best prepare to provide such thought-filled and thought-provoking curriculum to our children? In studying how the gifted brain learns, Sousa (2002) found that "open-ended questions are effective for encouraging creative thinking because they rarely have one answer and they stimulate further inquiry. They ask for clarification, probe for assumptions, search for reasons and evidence, and look for implications and consequences" (p. 76). Separately, in studying creative problem solving within the mathematics domain, Lin and Cho (2011) found that "intrinsic motivation positively influences creativity, but the effect of extrinsic motivation is controversial" (p. 256). The above two findings provide us with some implications for our teaching. To provide an optimal environment to encourage creativity in our children, foremost, we must ensure that we improve our questioning to include an ample amount of open-ended questions. While studies provide evidence for creativity requiring mastery of concepts and skills, creativity will not emerge from an environment where there is a focus on single-answer responses. The minds of our children must be challenged and stimulated. In order to cultivate creativity in our children, educators have to provide an environment where children practice their convergent and divergent thinking skills to define problems, search for solutions, and evaluate outcomes. They need opportunities to think deeply about possible reasons with supporting evidence, hypothesize on possible consequences, and ponder its implications. Instructional tasks also need to be more engaging and relevant to their real-lives. In this way, we tap into students' curiosity and intrinsic motivation, rather than an extrinsic one, such as the praise from a teacher for getting the correct answer. While many educators still focus on

"mastering" a content through a single-answer type of approach, educators must rethink our approach if we truly want to prepare our children for a world beyond education.

Exploring project-based learning (PBL) as a vehicle to promote creativity and problem-solving skills.

To be able to provide such "well-established environment for creativity… characterized by knowledge-based resources, stimulus, comfort, and a carefree surrounding" (Csikszentimihalyi, 1996), some schools have begun to employ project-based learning (PBL) approach. One typical example of PBL is the Renzulli's Triad Enrichment Model. This model "provides the opportunity for students to pursue their own interests by identifying solvable problems in an interest area and acquiring the skills needed to solve the problem. Through this process students work to develop an actual product for an identifiable audience" (Moller, 1986, p. 11). In essence, project-based learning propels students to utilize creativity and problem-solving skills to engage in an authentic, real-life task where the purpose is clear and meaningful to the learner. With the project-based learning approach to teaching and learning, students work within the context of a subject that is typically inter-disciplinary, working together with peers to construct meaning while completing the task. Some examples may include group of students working on a local environmental problem, a local political situation, health crisis, etc. Outside experts may be called upon to provide professional advice and answer questions generated throughout the learning process (Anderson, 2010). In this model, the teacher takes on a facilitator role. This model is in stark contrast to traditional schools where the teacher typically focuses on delivering information to students.

Project-based learning (PBL) and the development of a supportive learning environment that promotes rigor and high expectations.

How does the project-based learning approach affect the learning environment and students' learning outcomes? In a 3-year project funded by the National Aeronautics and Space Administration (NASA), DeWaters, Andersen, Calderwood, and Powers (2014) sought to investigate the relationship between attributes of the PBL modules on climate literacy to middle and high school students' academic gains. In addition, DeWaters et al. (2014) sought to investigate the level of rigor and relevance associated with the learning activities within the PBL modules, as well as the changes in students' affect and behavior. 20 science teachers (6 middle school and 14 high school science teachers) participated in the program. A total of 427 students participated in taking a pre and post questionnaire, which contained 3 subscales: climate-related affective, behavioral, and cognitive aspects. ANCOVA analysis was conducted to examine the impact of the PBL instruction on students' learning of content and the impact on students' affect and behavior towards the modules. Eleven modules were also analyzed to define the level of rigor and relevance of the material, based on the Rigor & Relevance (R&R) Framework developed by Daggett (2005). The analysis showed that 9 out of 11 modules had 50%+ of the activities in quadrant four of the R&R Framework, indicating that the majority of the activities required critical thinking skills at a higher end of Bloom's Taxonomy (p. 473-475). In discussing student results, DeWaters et al. (2014) reported that students made "statistically significant gains on the cognitive ($p<<0.001$) and the affective ($p<0.01$) climate literacy subscales. Results of the fixed effects analysis of covariance showed a significant difference among classrooms on students' cognitive

($p<0.001$), behavioral ($p=0.001$), and self-efficacy ($p=0.015$) performance" (p. 469). The opportunity for students to engage authentically with real-life issues and data, as well as the ability for students to engage in problem-solving on their own, resulted in a high level of student engagement in critical thinking skills and increased student ownership over the content. This study suggests that the PBL approach to teaching promotes an environment of rigor and high expectations for students. There were some limitations to this study. Limitations included the instrument used to measure students' academic gains. The growth in students' academic achievement was measured through students' self-assessment of their learning using a survey created in a Likert-scale. Likewise, the level of rigor and relevance of the PBL modules was measured through teachers' self-assessment of their own modules, based on the Rigor & Relevance (R&R) Framework. The instruments in this study not being standardized, as well as the possible subjectivity and variability amongst teachers and students were major limitations of this study.

In another study, Hugerat (2016) explored how the PBL approach to teaching science affects the classroom learning environment. In this study targeting 458 ninth grade students in two middle schools in the Northern District of Israel, approximately half of the target population (230 students) was provided with science instruction using the PBL approach and the other half of the target population (228 students) was provided with traditional science instruction. A questionnaire developed by Zedan (2008), consisting of 38 items, was used as the primary instrument in this study to measure students' perceptions of the classroom climate. The result of the study revealed that students in the PBL group were "significantly more satisfied, enjoyed the class more, and perceived that their teacher was more supportive (Factor 1) and that they perceived

teacher-student relationships (Factor 5, Table 2) as being significantly more favorable than those who learned sciences by frontal non-project-based learning strategies" (p. 391). Furthermore, students in the PBL group felt significantly less tense in the classroom and perceived the instructional tasks in the classroom to be less difficult than the traditional group. Hence, in addition to the PBL approach supporting an environment of rigor and high expectations for students, this study suggests that PBL approach to teaching also produces a positive and supportive learning environment where students gain opportunities to develop self-efficacy and ownership over their own learning through safe and positive relationships with one another. One limitation to this study is that the instrument used to measure the learning environment of the PBL and non-PBL classrooms only contained questions pertaining to the climate of the classroom, not the culture of the classroom. In other words, the 38 items on the questionnaire largely targeted how students felt to be a part of the classroom environment (e.g. welcoming, satisfying, intense, etc.), and not targeting the shared values, beliefs, and practices in the classroom (e.g. collaboration, challenge, growth mindset, etc.). In this way, Hugerat's (2016) assertion of "creation of a positive educational climate that enabled the teacher to achieve the lesson objective" ignored the *culture* of the classroom environment that work in tandem with the climate of the classroom to support students' learning.

Project-based learning (PBL) and the development of a rich oral learning environment that promotes student discussions and collaboration.

Walters and Sirotiak (2011), conducted a study assessing the effect of project-based learning on "soft skills", such as leadership abilities and communication skills. In this study, participants were approximately 70 undergraduate students from Iowa State

University enrolled either in a senior capstone class in the Fall semester of 2005 or in the Spring of 2006. The single semester class engaged students in an active learning environment that utilized the project-based learning (PBL) approach for the duration of the semester. Students took a pre and post-test using the Competing Values Skills Survey (CVSS), which measures various non-technical skills, such as leadership and communication. In the Fall 2005 semester, 14 students participated in the pre-test and post-test. In the Spring 2006 semester, 42 students participated in the pre-test and post-test (56 samples combined in 2 cohorts). Results of the paired T-tests between the pre and post tests showed a statistically significant growth in the students' ability to develop and communicate a vision with the Fall 2005 cohort with ($t_{(13)}$, -2.329, p<.05). Likewise, the Spring 2006 cohort also showed a statistically significant growth at ($t_{(43)}$, -2.712, p=.01). Both cohorts combined, there was a statistical difference of (t (57), -3.439, p =.001). In addition, the communicating effectively competency showed a statistical difference for Spring 2006 (t (43), - 2.012, p =.051) and for Fall 2005/Spring 2006 (t (57), -2.555, p <.05) (p.6-7). According to Walters and Sirotiak (2011), the results of this study suggest that "PBL can positively influence several soft skills of the population studied. In addition, the findings of the study suggest that confidence and stress coping, leadership and communication, and adaptability and management skills are all positively influenced. During this process, the results also suggest that students were influenced in a more holistic manner as they were influenced by the real-world application that PBL provides" (p.7). In other words, PBL approach to teaching encourages students to engage in the content and with one another meaningfully, leading to a broader and more long-term

learning outcomes, which include the development of softer skills such as communication skills.

In a study targeting Iranian junior high school students, Shafaei, Poorverdi and Parvizi (2007) explored the impact that PBL had on the growth of students' vocabulary knowledge and communicative ability. In this study, they targeted 26 junior high school students (13 in the PBL group and 13 in the control group). The PBL group engaged in instruction where the lessons were developed in ways that "Highlight provocative issues or questions that lead students to *in-depth exploration of authentic and important topics"* (p.4). PBL instruction also emphasized self-management and self-agency in their learning, as they were encouraged to collaborate and communicate with one another in small groups, student-led presentations, and/or peer feedback. The study compared the results of the difference between pre and post vocabulary test of both groups: PBL and control group. The findings showed the PBL group with the score of 2.42 and the control group with the score of 2.17, illustrating a higher growth amongst students in the PBL group on the English vocabulary test (p. 7-8). Shafaei, Poorverdi & Parvizi (2007) explain, "Classroom activities may be of various types. They may center primarily on usage or use. They may require the student to receive a message or produce one. They may involve whole class activities, small group interaction, or individual work. They may be based entirely on the text, related directly to the material in the text, or selected purposefully from other sources" (p. 2). In other words, the overall intended outcomes steered by the teaching approach impact the learning environment and student expectations, which in turn impact actual student outcomes. The PBL approach to teaching, with its emphasis on the authentic process of learning, rather than the mastery

of procedures or correct answers, leads to the students' attainment of broader set of skills. More specifically, the emphasis that PBL approach has on student discussions and collaboration sharpen students' "communicative, thinking and problem-solving skills" (p. 2). Bell (2010), in her explanation of PBL supporting the development of 21st century skills in an article, explains that "PBL promotes social learning as children practice and become proficient with the twenty-first-century skills of communication, negotiation, and collaboration….Students learn the fundamental skills of productive communication, respect for others, and teamwork while generating ideas together" (p.40-41). Again, the findings from Walters and Sirotiak's (2011) study and Shafaei et al.'s (2007) study suggest that the emphasis on the creation of a rich oral environment in the PBL approach to teaching support students' academic outcomes, as well as other "softer" learning outcomes, such as creativity, problem-solving skills, communication skills, and collaboration skills. There were some limitations in the studies conducted by Walters and Sirotiak (2011) and Shafaei et al. (2007). The limitations of the two studies included the narrow scope and the limited number of participants, many of the participants either electing not to participate in the study or continue with the study, and the study being limited to one school, which made it difficult to generalize it to a larger population. The instrument used in the study conducted by Shafaei et al. (2007) was also unclear, which raised the question of validity of the instrument used.

Project-based Learning and its Impact on Academic Achievement

Project-based learning and its impact on academic achievement in ELA and social studies.

The quality of school and classroom environments are undoubtedly one of the most critical factors that impact students' academic achievement. In addition to studies that show a strong correlation between PBL approach and positive classroom environments, many studies also show a strong correlation between PBL and students' academic attainment. In a report describing a three-year project study launched by Expeditionary Learning Outward Bound USA (ELOB) in 1992, Weinbaum et al. (1996) evaluated the impact of ELOB project-based learning curriculum on students' academic achievement in the schools participating in the study (four elementary schools, one middle school, one K-8 school, one 6-12 school, one K-12 school, one regional vocational center, and one alternative high school). The participating schools were located in Boston, Denver, Dubuque, New York City, and in Portland. In the academic year 1993-94, approximately 5,400 students were enrolled in these participating schools combined. In this study, they found that nine out of ten Expeditionary Learning schools increased student achievement steadily over the years. Most positive increases were seen in the three elementary schools in Dubuque where there were significant improvements in the standardized ELA and math standardized exams given by the state of Iowa (p. 23). While the ELOB study covered expansive number of students across various schools and regions, one limitation of this study was that there was no common assessment for these schools. In addition, there was a significant variability across the schools due to the differences in regions, school level, differing stages of ELOB implementation, and support.

In a study conducted by Summers and Dickinson (2012), they examined the impact of the project-based learning approach to teaching social studies, compared to a

more traditional approach, on four years of high school students' academic achievement in social studies, evidenced by social studies standardized exams. This longitudinal study was conducted in two rural high schools within the same district. One high school utilized a PBL social studies curriculum while the other high school utilized a traditional social studies curriculum. Summers and Dickinson (2012) found that students from a project-based learning rural high school had "significantly higher percentage of PBL students scored at the pass and commended levels for all three applicable testing years than their counterparts at Trad HS", a more traditional high school in the same district (p. 97). Summers & Dickinson (2012) also found that project-based learning may also provide greater equity for diverse school systems serving different communities (p. 99). This research showed that while both traditional and project-based learning approach to teaching and learning can be effective in promoting academic achievement on standardized tests where question types are largely geared towards testing rote, factual knowledge, project-based learning approach was significantly more effective in helping students attain conceptual knowledge and preparing students to apply their knowledge to new situations in and out of the classroom. The limitation in this study was the limited number of schools studied. While the study interestingly compared two schools within the same district in close proximity, having just one sampling of a PBL school and one traditional school as a comparison group limited the study.

Project-based learning and its impact on academic achievement in mathematics.

The results from studies conducted by Weinbaum et al. (1996) and Summers and Dickinson (2012) support Boaler's (1998b) findings that employing approaches to teaching and learning that focus on developing students' creativity, critical thinking, and

problem-solving skills positively impact students' academic achievement, as well as performance outcomes beyond the classroom. In a three-year ethnographic case study, Boaler (1998b) analyzed students' growth of mathematical understanding in two different schools, one traditional school where teachers taught from a mathematics textbook and a more progressive school where teachers employed a project-based learning approach to teaching mathematics. As part of the longitudinal study, Boaler (1998b) analyzed a cohort of students in one grade in each school, following them from age 13 to age 16. Over 80 to 100 lessons were observed in each school and approximately 20 students were interviewed each year of the study to gain an in-depth understanding of students' experience in learning mathematics using different instructional approach. Students in both groups were also tested with typical traditional closed questions that assess content knowledge, in addition to questions that required applied knowledge of mathematics. In this study, Boaler (1998b) found that students from the project-based learning school performed similarly to the more traditional school when it came to factual and procedural questions. On the other hand, students from the more traditional school did not score as well on questions testing conceptual knowledge, whereas students from the project-based learning school scored similarly well on both types of questions (p. 9-11). This study suggests that skills inherently taught through the project-based learning approach provide greater opportunities for students to develop creativity, critical thinking, and problem solving skills within the context of the discipline, which allows students to be able to apply their learning to their lives beyond the context of the classroom. While this ethnographic study provided a more flexible and in-depth view into the classroom and the

minds of students, the potential for researcher's biases and/or subjectivity was nevertheless a potential limitation of this study.

In another study, Han, Rosli, Capraro and Capraro (2016) examined the impact of PBL lessons on students' academic achievement in four areas of mathematics, compared to lessons taught using traditional, text-book approach. The results of the state standardized mathematics test, Texas Assessment of Knowledge and Skills (TAKS), was used to measure students' academic achievement in this study. This study was a 3-year longitudinal study (2008-2010) targeting a diverse population of students in six urban schools in a lower socio-economic neighborhood. Teachers from three schools received extensive professional development on PBL approach to teaching and implemented PBL lessons in mathematics and science throughout the 3 years of this study. On the other hand, the teachers in the rest of the participating schools did not receive any professional development on PBL and taught students using a traditional, text-book model. ANOVA tests were conducted separately for students in PBL and non PBL schools to examine whether there were statistically significant differences for students' academic achievement in any of the four mathematics sub-areas: algebra, geometry, probability, and problem solving. From this analysis, Han et al. (2016) found that both PBL and non-PBL lessons generally improved students' mathematics scores across all 3 years. On the other hand, it was also found that students in PBL schools showed improvements in problem solving throughout *all three* years, whereas students in non-PBL schools showed stagnant scores in problem-solving from Year 2 to 3. Additionally, T-tests were conducted to compare students' academic achievement in the four sub-areas between students from STEM PBL schools versus students from non-STEM PBL schools. From

this analysis, it was found that students from PBL schools performed higher than students from non-PBL schools in the areas of geometry, probability, and problem solving (p. 8). This study used a utilized a sample of 6 participating schools (3 PBL and 3 traditional). The small number of schools studied posed a limitation to this study.

In a study exploring the impact of Science, Technology, Engineering, and Mathematics (STEM)-based PBL education on the academic achievement of 11th grade students at a vocational high school, Çevik (2018) found that students made statistically significant academic gains, as well as strengthen their career interests through PBL education. This study targeted 18 students in The Central Vocational and Technical High Schools in the province of Karaman and utilized the STEM Achievement Test, developed by Cevik (2018), to measure the students' academic gains. Cevik (2018) also utilized the STEM Career Interest Scale, "The 5 Likert-type scale consisting of 40 items developed by Kier et al. (2014) and adapted to Turkish by Koyunlu Ünlü et al. (2016)" (p.285), to measure the students' career interests and enthusiasm for STEM-related vocational fields. Pre and post-tests were administered and the difference between the pre and post-tests were analyzed to measure both academic gains and the level of students' interest in STEM careers for this study. Results showed that "students improved significantly their academic achievement in the furniture design course and developed career interests in a positive direction" (p. 281). In addition to making significantly positive academic gains between pre and post-tests, students also gained a significant level of interest and enthusiasm for careers in STEM, with the largest increase in enthusiasm for engineering. These studies suggest that employing the project-based learning approach is either more effective, or equally as effective as traditional teaching methods in supporting students on

standardized exams. This study was conducted using a single group, pre and post test design. A limitation of this study was not having a control group to make comparisons with. Nevertheless, all three studies also show that PBL approach to teaching is significantly more effective in producing students who gained long-term conceptual knowledge, which can be used to problem-solve in new situations (Boaler, 1998b).

Barriers to implementing project-based learning (PBL) in the classrooms.

Despite the overall positive research findings on the PBL approach that emphasize the development of creativity, critical thinking, and problem-solving skills, there are many barriers that exist to employing this innovative approach to teaching and learning. One key factor is an increase in accountability of schools and teachers through high-stakes standardized testing. Omdal and Graefe (2017) state, "Certainly changes to the teacher evaluation systems have been undertaken with the best of intentions; however, in this movement toward great educator accountability through the use of high-stakes assessments, teachers' desire to teach creatively is often trumped by the need to ensure that students are making adequate progress toward a testing goal" (p. 211). Mansilla and Gardner (2008), in the article, "Disciplining the Mind", also discuss this unintended phenomenon. They agree that "there is an appealing sense of efficiency in subject-matter teaching: Teachers can rapidly present large quantities of information to students and easily test this information. The apparent benefits pale, however, when we consider how the young human mind develops and how best to prepare that mind for the future…Although students have little trouble spewing forth information that they have committed to memory, they display great difficulty in applying knowledge and skills to new situations" (p. 15).

Despite all the research findings, our educational system in United States reflect a poor effort in developing "knowledge arts", which include promoting students to think critically and creatively. According to Perkins (2011), "The report card for business-as-usual schooling would look like this: creating knowledge: D, communicating knowledge: B, organizing knowledge: C, and acting on knowledge: D" (p. 243). In typical schools, inquiry-oriented activities are sparse, the process of attaining knowledge passive, and attending to content learning exist in the narrowest sense. If we want to close the achievement gap that exist in urban communities, we must help students bring "knowledge to life by requiring students to manipulate knowledge" in creative ways (Perkins, 2011, p. 245). The negative effect of remaining stagnant in this endeavor would be especially detrimental to students of color in urban communities where such opportunities are especially lacking. The reality is that the unintended negative impact of accountability of schools and teachers is especially more profound in struggling schools in urban communities, as the urgency to improve test scores is more dire. As a result, struggling schools are encouraged to focus on test scores, which tend to steer teachers away from taking a perceived risk that may possibly come with adopting a more innovative approach to teaching, such as PBL. The unfortunate consequence of this situation is that students of color disproportionally are left out of instructional opportunities that sharpen students' creativity, critical thinking, and problem-solving skills necessary to succeed in the 21st century. The negative impact of this phenomenon may be far more lasting than scores on a standardized test. Again, if we are serious about closing the achievement gap, we must take a proactive stance and take deliberate steps to shift our instructional practice to bring educational equity for all our children.

Connection Between Project-based Learning (PBL) and Culturally Relevant Pedagogy

Critical race theory and the fight for social justice within education.

Critical race theory provides a framework to explain and to further explore how the effort to close the achievement gap in education between different subgroups of people may directly impact our larger goal of social justice. Solórzano and Yosso (2015) claim that "critical race theory advances a strategy to foreground and account for the role of race and racism in education and works toward the elimination of racism as part of a larger goal of opposing or eliminating other forms of subordination based on gender, class, sexual orientation, language, and national origin" (p. 25). Researchers do not all agree on a common definition of Critical Race Theory, or a "canonical set of doctrines or methodologies to which CRT scholars all subscribe" (Crenshaw et al., 1995), but the common interests that bind all critical race theorists together are the goals to understand how racism and racial privilege has been maintained for so many years, and the common commitment to break the relationship between law, race, and power. Ladson-Billings (1998) provides a helpful outline of Critical Race Theory:

1. A key strategy of CRT is placed on "unmasking and exposing racism in its various permutations" that continue to prevail within the fabric of our society on all levels.
2. CRT embraces storytelling as an important tool, departing from traditional scholars.
3. CRT calls us to actively critique "flawed" *liberalism*, which had led a painstakingly slow civil rights movement.
4. CRT poses an argument that Whites have primarily benefited from civil rights movement, such as affirmative action, since the largest percentage of the recipients of such movement has been white women (p. 12-13).

The strengths of CRT, as it relates to education, includes teaching students to assume a proactive stance on fighting for social justice. As Gloria Ladson-Billings (1998)

alluded to in her article, the civil rights movement of the past has slowed down in recent years. Not only has the progress been very slow, but in our current political climate, we seem to be taking steps back. Taking a more proactive approach of CRT may be a necessary step to change the narrative and the direction of the strong tides of racism in our society. CRT can be adapted across disciplines, providing a common language for all of us to continue to grapple with and to make advancements together, while developing critical thinking skills to problem-solve this complex issue.

A potential weakness of CRT is the potential for the loss of control as it begins to take root. Ladson-Billings (1998) warns, "It is the pattern in educational research for a new idea or innovation to take hold and proliferate. Sometimes an idea takes a while to take root, but once it does, most likely its creators lose control of the idea. Consider what happened with the notion of cooperative learning" (p. 26). Especially with such an emotionally charged topic, there is a real potential for the idea to lose control in a national debate and to produce adverse effects. Therefore, it is very crucial for us to proceed with wisdom and caution. Another weakness may be the potential for us to lose sight of other factors that contribute to low academic outcomes for students of color. For example, socio-economic factor plays a large role in the disparity seen in education. CRT, if we do not proceed with caution, has the potential to lead educators to think in a very linear manner, attributing all "problems" to the problem of race, thereby leading us to miss opportunities to affect real changes.

Connection between students' preferred learning styles and culturally relevant instruction.

In a study exploring the preferences of African American students toward culturally relevant lessons (compared with non-culturally relevant lessons) in a large urban high school located in Colorado, Sampson and Garrison-wade (2011) found that culturally relevant teaching play a large factor in students' academic achievement. This study targeted African American students enrolled in a mixed grade (9–12) American History class through a six-week period. After the six-week period, all students in the class were given a feedback survey to complete and a focus group of six African American students were created to review the students' responses on the quantitative and qualitative data on the student feedback survey. Four important themes that emerged from this study were that "(1) Culturally relevant lessons are empowering; (2) Students enjoyed the engaging experientially-based activities; (3) Teacher style, tone of voice, and interest in lesson is imperative to learning; and (4) It is important for the teachers to understand and embrace cultural differences" (Sampson and Garrison-wade, 2011, p. 296). This study confirms the assumption that the level of students' engagement with content and students' academic success, thereof, is strongly tied to instruction that validates students' cultural experiences and preferred learning styles, while maintaining a high level of expectation. A limitation of this study was that the researcher fulfilled a double role as a researcher and teacher in the culturally relevant lessons. Students in the class also showed a level of comfortability with the teacher/researcher in delving into the topic of race and race issues in relation to the content being studied due to the fact that the researcher was African American. The researcher also discussed that it was difficult to remove her cultural and ethnic identity in the process. Therefore, the possible bias of the researcher was a limitation in this study. Nevertheless, the study sheds light on the

importance of shifting our practice to maintaining a high level of expectation for all students, while validating students' cultural differences and possible learning preferences to increase the level of engagement.

Bond (2017), a researcher who conducted a comprehensive review of culturally responsive education in the field of music education states, "Culturally responsive education (CRE) is a pedagogy used to validate students' varied experiences, and to teach *to and through* their strengths. CRE emphasizes high expectations, the formation of cultural competence, and development of critical consciousness" (p. 153). Supporting Sampson and Garrison-wade's (2011) study, Bond (2017) further explains that culturally responsive educators aim for students' high academic achievement, while simultaneously developing students' cultural competence. She also states that "(Culturally responsive) teachers acknowledge the variation that exists in students' preferred learning style and psychological need, and use this understanding to influence their teaching style and strategies" (p. 165). Thus, if we are serious about closing the achievement gap that exist in our society, we must make a commitment to delve deeper into culturally relevant pedagogy and make a concerted effort to create a supportive learning environment for all our students where we teach "to and through" the various cultural assets that our students bring to the table.

In the article, "It doesn't add up: African American students' mathematics achievement," Ladson-Billings (1997) states, "Students treated as competent are likely to demonstrate competence. Much of the literature on teacher expectations of student achievement helps us understand that when teachers believe in students' abilities, the students are likely to be successful. Conversely, when teachers believe that because of

their race, social class, or personal economic situations students may not be intellectually able, student performance (and how it is assessed) confirms those beliefs" (p. 5). Interestingly, Ladson-Billings (1997) explains that parents in Asia tend to attribute their child's mathematics failure to a lack of effort, while parents in the U.S. attribute mathematics failure to a lack of "innate ability" (p. 2). The expectations we portray to our students is critical to students' growing development of themselves as learners and the scope of their academic achievement.

In the effort to bring an awareness of the underlying factors that contribute to the achievement gap that exist between white and African American students, Rovai, Gallien, & Wighting (2005) examined the underperformance of African American university students and the cultural, communication, and learning styles that generally characterize African American students. In addition, Rovai et al. (2005) juxtaposed these characteristics with the common instructional practices prevalent in our universities today. According to the study, "the relationships of communication to culture and learning cannot be overly stressed, as these variables are at the heart of educational processes" (p. 361). Furthermore, they state that "African Americans learn more successfully in environments characterized by harmony, cooperation, affect, socialization, and a strong sense of community, and learn less in environments that are highly stratified and competitive" (p. 363). On the other hand, the authors claim that instructional practices that are dominant in our society today mostly consist of lecture and question-answer techniques that are "antithetical" to African American students' "dominant learning styles of cooperation, extensive interaction, and field dependency" (p. 364). Therefore, it is critical for us to reexamine our instructional practices and to make

intentional adjustments to ensure that our instruction is culturally relevant, promoting a learning environment of high expectations, communication, and collaboration.

Project-based learning (PBL) as a viable approach to delivering instruction that closely aligns to the tenets of culturally relevant pedagogy.

What are the characteristics of a culturally relevant pedagogy and how does that relate back to project-based learning? In a study exploring the question, "How do I teach mathematics in a culturally responsive way?" Ukpokodu (2011) engaged 45 pre-service and in-service enrolled in a graduate course, Teaching and Learning in Urban Classroom, in the spring semester of 2009 and 2010. Together, teachers examined culturally relevant teaching practices within the context of mathematics education and brainstormed how teachers can "engage in culturally responsive curricular practice given today's high-stakes testing." They also discussed what culturally responsive curriculum in math would look like and derived at the following seven important themes:

1. Deconstruct misguided beliefs about mathematics teaching and learning;
2. Integrate culturally relevant content and social justice issues;
3. Utilizing culturally responsive instructional strategies;
4. Foster communal learning;
5. Openness to students' divergent thinking and problem-solving;
6. Detrack the mathematics classroom; and
7. Teacher's critical consciousness, advocacy, and activism.
   (Ukpokodu, 2011, p. 40)

Interestingly, the themes that emerged from this study closely resemble that of project-based learning. The emphasis on high expectations for learning, a supportive environment of a "communal" learning community, deliberate attention to developing students' divergent/convergent thinking and problem-solving, and the importance placed

on the relevancy of the curriculum, as well as the authenticity of content to real-life issues, are overlapping themes between PBL and culturally relevant pedagogy.

In a 3-year study conducted by Mitchell and Taylor (2017), students who were enrolled in an in-school academic intervention program called Community as a Classroom (CAC) were engaged in critical project-based learning opportunities. This initiative focused on teaching students to critically analyze the conditions of their neighborhood, and to participate in problem-solving in real-life. The study investigated the resulting academic achievement of the participating students who attended a low-performing school in Buffalo, New York. Many factors were analyzed to investigate academic achievement of the students, including standardized test scores. The data for this study was pooled from cross sections of approximately 80-120 students ranging from fourth through eighth grade for three academic years from 2011–2014. The study found that CAC students performed significantly higher than non-CAC students on both the standardized ELA and Math exams, with the standardized Math exam showing a larger significant difference of the two independent variables. In addition, the improvements in the standardized test, particularly mathematics, were most dramatic with the lower performing student group. Mitchell and Taylor (2017) state that the "results are extremely encouraging and suggest that greater attention should be paid to pedagogy in the formulation of school reform strategies. The Community as a Classroom initiative uses critical pedagogy method and utilizes a curriculum based on critical project-based learning…It is this connection between critical consciousness and critical motivation that drives them along this proximal-distal continuum of academic improvement" (p. 18). A limitation in this study was that the CAC program itself was limited to pool from a

specific cross-section of the student body to draw participants due to other academic intervention programs being provided to students with high academic needs. Therefore, the limitation of this study was that the sampling of students may not have been controlled to represent students from all academic levels.

Kim, Cho, Couch, and Barnett (2019) conducted a study examining the benefits of a middle school "invention" curriculum, which followed the project-based learning approach to teaching science, while incorporating the tenets of culturally relevant pedagogy over the course of two months. The content of this science-based curriculum focused on the topic of heat energy. It also included seven Home Fun activities that drew on students' knowledge of their home cultures. Activities ranged from writing about important inventions made in their home country to brainstorming about articles of clothing that was invented in their home country to keep people warm/cool. In this study, Kim et al. (2019) used multiple case study method to analyze the data of students, including 5 target English Language Learners from two middle schools in the northeastern part of U.S. Interviews, observations, and researcher journals were coded and analyzed to find emerging themes. Findings demonstrated that this invention-based curriculum, presented using the project-based learning approach, "afforded students new opportunities to engage with the science curriculum…(Students) used positive terms to describe the experience and words that suggest they gained confidence along the way" (pp. 263-264). Providing avenues for students to connect back to their home cultures also provided scaffolds, improved communication, and increased students' pride. Kim et al. (2019) explain that "intentional efforts to recognize students' cultures as funds of knowledge contributed to students' active engagement in learning. In this case study, in

which the teacher paid attention to what students were bringing to the classroom and treated their backgrounds as assets, students moved beyond simply learning rudimentary skills as they developed their academic writing and scientific literacy" (p. 265). This connection between PBL and culturally relevant pedagogy is exciting as it provides a practical roadmap that we can explore further to close the achievement gap remains so persistent in our society. While this qualitative study provided an in-depth view into the classroom and the minds of English Language Learners who are often overlooked, the potential for researcher's biases and/or subjectivity was a potential limitation of this study. Furthermore, future studies on the impact of culturally relevant PBL instruction on students' academic achievement using a more standardized method and instrument is needed.

Summary

The purpose of this review of literature was to explore the connection between the development of students' problem-solving skills by employing project-based learning (PBL) as a core method of instruction, and its impact on students' academic achievement across content areas. The literature review examined project-based learning and its impact on the learning environment, and on academic achievement, and the connection between project-based learning (PBL) and culturally relevant pedagogy that could serve as an avenue to close the achievement gap that continues to persist in our education. Based on this review, we can expect that PBL develops a supportive learning environment that promotes rigor and high expectations, as well as a rich oral learning environment, which promotes a high level of student discussions and collaboration. The literature review also seems to suggest that the positive environment that PBL promotes

leads to increased academic outcomes across content areas. Despite the encouraging results present in current research on PBL and academic achievement, the pressure from high-stakes testing presents a strong barrier to schools adopting PBL. However, results from recent studies, the growing interest in culturally relevant pedagogy, and the connection culturally relevant pedagogy has to the type of environment promoted by PBL, provide an encouraging and exciting roadmap for us to pursue that may help close the achievement that persists in our education today.

While the literature review provided many exciting examples of the connection between the development of students' problem-solving skills by employing project-based learning (PBL), and its impact on students' academic achievement, there were some major gaps. The gaps included the limited sample size in many of the studies reviewed. In many of the studies reviewed, only one school or a few students were studied, making it difficult to generalize the findings. Another gap was the limit in the time frame of the intervention. The brevity of the intervention time in many of the studies made it difficult to ascertain the amount of actual impact that PBL approach to teaching and learning had on students' academic outcomes. In some of the studies, the instrument used was also somewhat unclear as well or not fully standardized, especially in the cases of self-assessments, which prompted the question of reliability. Lastly, the potential for researcher's biases and/or subjectivity was a potential limitation of some of the studies reviewed.

The literature review provided a strong foundation for this research. This quantitative research, which reviews standardized data of all 72 schools in two urban districts within the same regional area is aimed at expanding the current literature on

project-based learning (PBL) and its impact on students' academic achievement. The following chapter describes the methods and procedures of the study, which includes the research design, the sample and population, instruments used, and the statistical analysis conducted to analyze the results.

CHAPTER 3

Methods and Procedures

Research Design and Data Analysis

The purpose of this study is to examine the impact of project-based learning (PBL) on students' academic achievement. The impact of PBL is being explored as a viable example of an instructional approach that emphasize the development of students' creativity and problem-solving skills that is critical in the 21st century. This study also examines the impact of the different approaches of instruction (PBL and traditional) on the school environment and the quality of discussion, which include establishing high expectations and a safe culture of learning where students contribute to a high level of discourse and collaboration with one another.

This non-experimental/correlational quantitative study examined schools that emphasize the development of students' problem-solving skills by employing project-based learning (PBL) as a core method of instruction, and its impact on students' academic achievement in ELA and in Mathematics, in comparison to schools that employ traditional teaching methods. The results of the Grade 4 and Grade 8 New York State ELA Test and New York State Mathematics Test were examined to reflect students' academic achievement. The mean difference between the test scores from the two different groups (PBL vs. traditional) were analyzed to evaluate significance. Students' data on the 4th and 8th grade NYS ELA and Math Test were also compared between PBL schools currently at a lower level of PBL implementation versus PBL schools at a higher level of PBL implementation based on PBL School Rubric by Buck Institute for Education. In addition, the result of the NYC School Survey in the sub-categories,

Rigorous Instruction: Quality of Student Discussions and Supportive Environment: Social-emotional, was analyzed to explore any correlations that exist between the different instructional approaches (PBL vs. traditional) on the school environment, which undoubtedly is one of the most important factors affecting student learning.

Research questions were as follows:

1. Will there be significant differences in students' achievement on the 4th and 8th grade NYS ELA Test between schools that employed PBL approach and schools that employed traditional teaching approach?
2. Will there be significant differences in students' achievement on the 4th and 8th grade NYS Mathematics Test between schools that employed PBL approach and schools that employed traditional teaching approach?
3. Will there be significant differences in the subcategories of the NYC School Survey, Quality of Student Discussion & Supportive Environment with High Expectations, between schools that employed PBL teaching approach and schools that employed traditional teaching approach?
4. Which predictors, teaching method (PBL vs. traditional), supportive environment of high expectations, and quality of student discussion, predict students' achievement in ELA and Mathematics significantly?

Reliability and Validity/Trustworthiness of the Research Design

This study investigated the impact of the teaching approach that emphasize the development of students' problem-solving skills, in this case, project-based learning (PBL), on students' achievement on the 4th and 8th grade NYS ELA and Math test, as compared to a traditional teaching approach. This was examined by analyzing 2018 test results of all schools in two different districts within the same borough of New York City (50 elementary schools- 19 PBL, 31 traditional, as well as 22 middle schools-10 PBL, 12 traditional). In order to increase the level of reliability and validity, the following steps were taken:

- Data from all schools in the 2 districts, located in the same borough in NYC, were reviewed for this study to ensure adequate sample size and to avoid any biases in the selection process.
- To operationalize the level of PBL implementation, PBL School Rubric from Buck Institute for Education was used. Superintendents and/or Deputy Superintendents in two urban districts were asked to carefully evaluate each of their schools on the level of PBL implementation using the PBL School Rubric. Schools were designated to be Schools at the beginning stages of PBL implementation were considered to be in the same category as traditional schools since implementation of any new initiatives requires time, on-going professional development, and support for shift in practice to occur. For the purposes of this study, traditional schools, as well as beginning PBL schools in "Significant Content "and "21st Century Competencies", were coded as level 1. PBL schools that have implemented PBL with some success but has some areas for growth

were coded as level 2 (as evidenced by the PBL School Rubric created by Buck's Institute for Education). Only PBL schools that have achieved full implementation of PBL features, evidenced by the PBL School Rubric were coded as level 3.

- The traditional schools selected for this study as a control group are also public elementary and middle schools in the same district in NYC with similar student demographics.
- Highly standardized assessments, the NYS English Language Arts exam and the NYS Mathematics exam, were chosen for this study to ensure a high level of reliability of the instrument used in this study.
- Results of the NYC School Survey were used to measure the school environment for its large sample size, validity, and reliability. A very high percentage of teachers complete the survey in each school, which ensured a large sample size. In addition, when teachers are completing the survey, they are not self-assessing their own classroom environment, nor their own pedagogical skills, but that of the school. The surveys are also completed anonymously. These factors increased the validity and reliability of the survey instrument used.

The Sample and Population

Sample.

50 elementary schools in NYC public school system across 2 districts:

- 19 elementary schools that employ project-based learning method of instruction
- 31 elementary schools that employ traditional method of instruction in the same district

22 middle schools in NYC public school system across 2 districts:

- 10 middle schools that employ project-based learning method of instruction
- 12 middle schools that employ traditional method of instruction in the same district

All schools designated to be teaching using the PBL approach are schools that have been recognized by the superintendent/deputy superintendent of the district for their successful implementation of PBL within their core instruction, evidenced by the PBL School Rubric.

Population.

The target population for this quantitative study were elementary and middle schools in an urban public-school system receiving ELA & Math instruction, either through a traditional method of instruction or through instruction employing the project-based learning approach.

Table 1

Participating Schools (n=72)

	Number	%
Grade Level		
Grade 4		
PBL	19	26.4
Traditional	31	43
Total	50	69.4
Grade 8		
PBL	10	13.9
Traditional	12	16.7
Total	22	30.6

Instruments

The New York State Grade 4 and Grade 8 English Language Arts Test and Mathematics Test were selected for this study for several reasons. First, the purpose of this study was to explore the connection between the development of students' creativity and problem-solving skills to academic achievement. Currently, the NYS ELA and Mathematics Test are common assessment tools being used at the state level to measure students' knowledge of the content and academic skills expected across schools in NYS. While the approach that individual schools take to deliver the core ELA and mathematics curriculum may differ from school to school, all curricula are based on the Common Core

Learning Standards for ELA and for Mathematics. Therefore, using a state-level common assessment that is required for both types of schools (PBL and traditional) as the main instrument for this study increased the validity of this study.

Secondly, this study examined classrooms that emphasize the development of students' problem-solving skills by employing project-based learning (PBL) as a core method of instruction, and its impact on students' academic achievement. The NYS English Language Arts Test was redesigned in 2013 to measure students' learning aligned with the instructional shifts necessitated by the Common Core Learning Standards: Balancing Informational & Literary Text, Knowledge in the Disciplines, Staircase of Complexity, Text-based Answers, Writing from Sources, and Academic Vocabulary. The 2019 Grades 3–8 English Language Arts Tests was developed to assess students' achievement of Reading, Writing, and Language Standards using multiple-choice, short-response, and extended-response questions. All questions were designed to test students' close reading skills of informational and literary texts, including paired texts. Students' achievement of Reading and Language Standards were assessed using multiple-choice questions. Short-response (2-point) questions primarily assessed reading, but required writing skills, as well as a broader command of language skills. Extended-response (4-point) questions assessed Writing from Sources, where students were rated on their level of communication and text analysis. The entire test was designed to test, not factual knowledge of literacy, nor technical grammatical skills necessary for the command of English Language Arts, but much larger skills of analysis, inferencing, developing and presenting viable arguments, and strategically and accurately citing evidence to substantiate their arguments. The Educator's Guide to the 2019 Grade 3-8

English Language Arts Tests states, "Only through rigorous, structured classroom discourse will students gain valuable experiences interrogating texts they need in order to meet the rigors of what is required in writing." As this study looked to examine the impact of PBL instruction emphasizing the development of students' problem solving skills leading to students' academic achievement, as it is defined in the more "traditional" sense with standardized testing, it was appropriate to select NYS ELA Test designed to test students' higher order thinking skills as an instrument for this study.

The NYS ELA Test consists of two sessions that are administered on two separate days and includes three parts: multiple-choice, short response, and extended response formats. The 4th grade exam includes 7 passages, 24 multiple questions, 6 short-response questions. Although the NYS ELA is an untimed test, on average, students in 4th grade likely will require 60-70 minutes to complete session 1 and 70-80 minutes to complete session 2. Students in 8th grade likely will require 80-90 minutes to complete session 1 and approximately 90-100 minutes to complete session 2. Session 1 consists of multiple questions only and session 2 consists of questions requiring short and extended responses. The 4th grade examination includes items in these approximate percentages: questions assessing students' ability to draw Key Ideas and Details weighted up to 65%, questions assessing students' analysis of Craft and Structure weighted up to 35%, and questions that require Integration of Knowledge and Ideas weighted up to 30%. The 8th grade examination includes items in these approximate percentages: questions assessing students' ability to draw Key Ideas and Details weighted up to 60%, questions assessing students' analysis of Craft and Structure weighted up to 40%, and questions that require

Integration of Knowledge and Ideas weighted up to 40%. The variety of question types, and the number of questions in the test, increase the reliability of the instrument.

The NYS Mathematics Test was also redesigned in 2013 to measure students' learning aligned with the instructional shifts necessitated by the Common Core Learning Standards: Focus, Coherence, Fluency, Deep Understanding, Application, and Dual Intensity. The 2019 Grades 3–8 Mathematics Tests was developed to assess students' achievement of mathematics using multiple-choice, short-response, and extended-response questions. All questions were designed to test students' deep understanding of mathematical concepts and their ability to apply them in new situations. Mathematical domains tested in the 4th Grade NYS Mathematics Test are Operations & Algebraic Thinking, Number and Operations in Base Ten, Number and Operations-Fractions, Measurement and Data, and Geometry. Mathematical domains tested in the 8th Grade NYS Mathematics Test are Expressions & Equations, Functions, Geometry, Number System, and Statistics & Probability. Multiple-choice questions incorporated math standards, Mathematical Practices, and real-world applications. Majority of the multiple-choice questions were designed to require students to utilize multiple steps thinking and problem-solving to solve them. In addition, some of the questions integrated more than one standard, requiring the simultaneous application of multiple skills and concepts. Distractors, all reflecting plausible missteps, were incorporated as one of the answer choices in each question to test students' ability to reason. Short-response questions on the test required students to conduct multi-step thinking, and to utilize their mathematical skills to real-world applications. Majority of the short-response questions focused on conceptual and application standards. Extended response questions required students to

complete two or more extensive tasks, assessing students' ability to apply their mathematical knowledge to real-world application. Many of the questions also required students to reason and to critique the arguments of others. NYS Math Test was designed to test students' multi-step problem-solving skills, and their ability to apply mathematical concepts to real-world problems. Therefore, as this study looked to examine the impact of PBL instruction emphasizing the development of students' problem solving skills leading to students' academic achievement, as it is defined in the more "traditional" sense with standardized testing, it was appropriate to select the NYS Mathematics Test as one of the instruments for this study.

The NYS Mathematics Test also consists of two sessions that are administered on two separate days and includes three parts: multiple-choice, shot response, and extended response formats. The 4th grade exam includes 38 multiple-choice questions, 6 short-response questions, and 1 extended-response question. Although the NYS Math is also an untimed test, on average, students in 4th grade likely will require 65-75 minutes to complete session 1 and another 65-75 minutes to complete session 2. Students in 8th grade likely will require 80-90 minutes to complete session 1 and approximately 75-85 minutes to complete session 2. Session 1 consists of multiple questions only and session 2 consists of questions requiring short and extended responses, as well as a few multiple-choice questions. The 4th grade examination includes items in these approximate percentages: Number and Operations in Base Ten - 20-30%, Number and Operations – 20-30%, Operations and Algebraic Thinking – 15-25%, Measurement and Data – 15-25%, and Geometry – 5-15%. The 8th grade examination includes items in these approximate percentages: Expressions & Equations - 40-45%, Functions – 25-30%,

Geometry – 20-25%, and Statistics & Probability – 10-15%. The variety of question types, and the number of questions in the test, increase the reliability of the instrument.

To explore the question, "What is the impact of a teaching approach that emphasize the development of students' problem-solving skills (such as project-based learning) on the school and classroom environment?", the NYC School Survey was utilized as an instrument. The NYC School Survey is administered annually to parents and teachers of students in all grades (3-K through 12), as well as to students in grades 6-12. The fact that the NYC School Survey collects information widely from all constituents in the school community, including parents, teachers, and students, increased the validity of this study.

The NYC School Survey collects information from school communities on the six elements of the Framework for Great Schools: Rigorous Instruction, Collaborative Teachers, Supportive Environment, Effective School Leadership, Strong Family-Community Ties, and Trust. Questions on the NYC School Survey is organized in groups relating to a measure, and groups of measures relating to an element. For example, the element of Supportive Environment, which was used for this study, is composed of seven measures: Classroom Behavior, Guidance, Peer Support for Academic Work, Personal Attention and Support, Preventing Bullying, and Safety. The survey also includes groups of questions related to each of the measures. For this study, items under the sub-category of Rigorous Instruction – Quality of Student Discussions and items under the sub-category of Supportive Environment – Social-emotional Learning, were analyzed. Survey questions under the sub-category of Rigorous Instruction – Quality of Student Discussions included the following:

How many students in your classes…

- build on each other's ideas during class discussions?
- use data or text references to support their ideas?
- show that they respect each other's ideas?
- provide constructive feedback to their peers/teachers?
- participate in class discussions at some point?

Teachers were asked to respond using a Likert-scale: none, some, a lot, all. Survey questions under the sub-category of Supportive Environment – Social-emotional included the following:

How many adults at this school…

- help students develop the skills they need to complete challenging coursework despite obstacles?
- tell their students they believe they can achieve high academic standards?
- teach critical thinking skills to students?
- teach students how to advocate for themselves?
- teach students the organizational skills needed to be prepared for their next level?
- recognize disruptive behavior as social-emotional learning opportunities?
- teach students the skills they need to regulate their behavior (i.e. by focusing their attention, controlling their emotions, or managing their thinking, behavior, and feelings)?
- have access to school-based supports to assist in behavioral/emotional escalations?

For the purposes of this study, the subcategory, Supportive Environment – Social-emotional, was renamed as Supportive Environment with High Expectations to accurately reflect the types of questions surveyed.

For the scoring of the NYC School Survey, schools were categorized by survey school type. Schools were then compared to other schools of the same survey school type (e.g. elementary, middle school). The following process was then used in order to generate a score for the NYC School Survey: Question-Level Percent Positive, Measure-Level Percent Positive, Measure Score, Survey Element Score. In the first step, Question-Level Percent Positive, the percent of "positive" responses were calculated for each question. Out of the four possible response options, the two most favorable options were treated as positive responses in the calculation. In the second step of the process, Measure-level Percent Positive, question-level percent positive values for all questions within the measure were averaged together. For example, Social-emotional is a measure within the element of Supportive Environment. The Social-emotional percent positive is the average of the question-level percent positive values on all the Social-emotional questions. In the third step of the process, Measure Score, the Measure-level Percent Positive score was converted to a Measure Score using metric in a scale of 1.00-4.99. Results close to the city average scores in the 3-bar range (3.00 – 3.99) while results substantially above average received scores in the 4-bar range (4.00 – 4.99). Alternatively, results substantially below average received scores in the 2-bar or 1-bar range (2.00 – 2.99 or 1.00 – 1.99). Cut levels were then implemented in each rating category.

Table 2

Rating Categories and Percent Positive Cut Levels (PP)

Rating Category	Percent Positive Cut Levels (PP)
Top of Scoring Range	citywide mean + 2 SD, not to exceed 100
Exceeding Target (4 bars)	citywide mean PP + 0.75 SD, not to exceed 95
Meeting Target (3 bars)	citywide mean PP – 0.5 SD, not to exceed 90
Approaching Target (2 bars)	citywide mean PP – 1 SD, not to exceed 85
Bottom of Scoring Range	citywide mean + 2 SD, not to fall below 0

The fact that all schools had a very high percentage of teachers complete the NYC School Survey as a standard, yearly procedure increased the reliability of the instrument. The variety of question types in this survey also increased the validity of this study.

Statistical Analysis

To compare students' achievement on the 4th and 8th grade NYS ELA Test between schools that employed PBL approach and schools that employed traditional teaching approach, an independent samples T-test was conducted to test for statistically significant difference between the two groups. In this study, the dependent variable was the NYS ELA Test result for each school. The independent variable was the type of teaching approach: PBL or traditional. An ANOVA test was also conducted to analyze the possible differences between schools at different implementation levels of PBL. Again, the dependent variable was the NYS ELA Test result for each school. The independent variables were the level of PBL implementation: level 1-Traditional or Beginning Stage of PBL Implementation, level 2 - School-wide Implementation of PBL, and level 3 – Full Implementation of PBL.

To compare students' achievement on the 4th and 8th grade NYS Math Test between schools that employed PBL approach and schools that employed traditional teaching method, a T-test was again conducted to test for statistical significance between the two groups. Similarly, an ANOVA test was also conducted to analyze the possible differences between schools at different implementation levels of PBL. The dependent variable in this ANOVA test was the NYS Math Test result for each school. The independent variables were, once again, the level of PBL implementation: level 1-Traditional or Beginning Stage of PBL Implementation, level 2 - School-wide Implementation of PBL, and level 3 – Full Implementation of PBL.

To compare the school and classroom learning environment between schools that employed PBL approach and schools that employed traditional teaching approach, ANOVA was conducted to test for significant differences between the two groups, PBL and Traditional, and the subcategories of the NYC School Survey - Quality of Student Discussion & Supportive Environment with High Expectations. The independent variables was the type of teaching approach, PBL or traditional, and dependent variables were the level of positive responses regarding the Quality of Student Discussion and the level of positive responses regarding the level of expectations and supports in the classroom (subcategory of the NYC School Survey - Supportive Environment with High Expectations).

Lastly, to examine which variables (teaching approach-PBL vs. traditional, supportive environment of high expectations, and/or quality of student discussion) predict students' achievement in ELA and Mathematics significantly, a regression analysis was conducted. The following chapter describes the results of the study.

CHAPTER 4

Results

The purpose of this study is to explore the connection between the instructional approach for developing students' creativity and problem-solving skills and academic achievement by comparing students' achievement on the 4th and 8th grade NYS ELA and Mathematics Test between schools that employ project-based learning approach as the core method of instruction versus schools that employ a traditional approach to teaching and learning. Students' data on the 4th and 8th grade NYS ELA and Math Test were also compared between PBL schools currently at a lower level of PBL implementation versus PBL schools at a higher level of PBL implementation based on PBL School Rubric by Buck Institute for Education. In addition, the result of the NYC School Survey in the sub-categories, Rigorous Instruction: Quality of Student Discussions and Supportive Environment: Social-emotional, was analyzed to explore any correlations that exist between the different instructional approaches (PBL vs. traditional) on the school environment, which undoubtedly is one of the most important factors affecting student learning. This chapter presents the results of the 4 research questions that are at the heart of this study:

Research question 1

Will there be significant differences in students' achievement on the 4th and 8th grade NYS ELA Test between schools that employed PBL approach and schools that employed traditional teaching approach?

Comparison of ELA academic achievement by type of teaching approach.

To compare students' achievement on the 4th and 8th grade NYS ELA Test between schools that employed PBL approach and schools that employed traditional teaching approach, an independent samples T-test was conducted to test for statistically significant difference between the two groups. In this study, the dependent variable was the NYS ELA Test result for each school. The independent variable was the type of teaching approach: PBL or traditional.

Hypotheses (Independent Samples T-test).

H_0 = There is no significant difference in students' achievement on NYS ELA Test between schools that employed PBL approach and schools that employed traditional teaching approach.

PBL develops a supportive learning environment that promotes rigor and high expectations, as well as a rich oral learning environment, which promotes a high level of student discussions and collaboration. Therefore, I hypothesize that the environment that PBL promotes will lead to increased academic achievement in ELA.

All schools.

As shown in Table 3, a total of 72 schools participated in this study: 29 PBL schools and 43 traditional schools.

Table 3

Participating Schools: Comparison of the 2019 NYS ELA results – All Schools (n=72)

	Number	%
Traditional	43	59.7
PBL	29	40.2

As shown in Table 4, the mean score on the NYS ELA for traditional schools was 598.03. The mean score on the NYS ELA for PBL schools was 607.38, which was higher than traditional schools by 9.35 points ($p = .000$). Moreover, the percentage data aggregated by the 4 different levels of performance on the NYS ELA shows that traditional schools have higher percentage of both level 1 (below grade-level standards) and level 2 (approaching grade-level standards) students compared to PBL schools. It also showed that there was a significant difference in the % of Level 1 and Level 2 students between PBL and traditional schools. The largest difference shown was between the percentage of level 4 students in PBL schools versus traditional schools with the 16.05 percent difference ($p = .000$). The t-test analysis showed that there was a significant difference in the ELA scores for traditional schools ($M = 598.03$, $SD = 7.83$) and PBL schools ($M = 607.38$, $SD = 8.03$) conditions; t (70) = - 4.963, $p = .000$. These results suggest that approach to teaching really does have an effect on students' academic achievement in ELA. Specifically, the results suggest that when schools employ PBL approach to teaching, students' academic achievement in ELA increases significantly.

Table 4

Independent Samples T-Test: Comparison of the 2019 NYS ELA results - All Schools (n=72)

Levels	Traditional			PBL					
	N	Mean	SD	N	Mean	SD	*t*	df	*p*
ELA Mean	41	598.03	7.83	31	607.38	8.03	-4.963	70	.000
% Level 1	41	21.33	12.17	31	9.93	6.28	4.754	70	.000
% Level 2	41	32.76	8.16	31	25.02	10.87	3.454	70	.001
% Level 3	41	29.02	9.85	31	32.11	7.86	-1.437	70	.155
% Level 4	41	16.89	10.11	31	32.94	19.37	-4.553	70	.000

4th grade.

As shown in Table 5, a total of 50 schools participated in this study: 19 PBL schools and 31 traditional schools.

Table 5

Participating Elementary Schools: Comparison of the 2019 NYS ELA results – 4th Grade (n=50)

	Number	%
Traditional	31	62
PBL	19	38

As shown in Table 6, the 4th grade mean score on the NYS ELA for traditional schools was 598.89. The mean score on the NYS ELA for PBL schools was 605.76, which was higher than traditional schools by 6.87 (p = .000). Moreover, the percentage data aggregated by the 4 different levels of performance on the 4th grade NYS ELA shows that again, traditional schools have higher percentage of both level 1 (below grade-level standards) and level 2 (approaching grade-level standards) students compared to PBL schools. It also showed that there was a significant difference in the % of Level 1 and Level 2 students between PBL and traditional schools. The largest difference shown was between the percentage of level 1 students in traditional schools versus PBL schools with the 9.83 percent difference (p =.000). The t-test analysis showed that there was a significant difference in the 4th grade ELA scores for traditional schools (M = 598.89, SD = 6.20) and PBL schools (M = 605.76, SD = 6.43) conditions; *t* (48) = -3.751, p = .000. These results, again, suggest that approach to teaching does have on students' academic achievement in ELA. More specifically, the results suggest that when schools employ PBL approach to teaching, even with young, elementary 4th graders, students' academic achievement in ELA increases significantly. Results also suggest that the impact of PBL approach is most profound for struggling students, based on the largest difference in the percentage of level 1 students between PBL schools and traditional schools.

Table 6

Independent Samples T-Test: Comparison of the 2019 NYS ELA results – 4th Grade (n=50)

Levels	Traditional			PBL					
	N	Mean	SD	N	Mean	SD	*t*	df	*p*
ELA Mean	31	598.89	6.20	19	605.76	6.43	-3.751	48	.000
% Level 1	31	20.72	9.83	19	10.89	6.25	3.897	48	.000
% Level 2	31	31.34	6.34	19	25.93	10.52	2.275	48	.027
% Level 3	31	30.33	9.39	19	35.32	4.17	-2.181	48	.034
% Level 4	31	17.60	9.26	19	27.87	14.0	-3.126	48	.003

8th grade.

As shown in Table 7, a total of 22 schools participated in this study: 12 PBL schools and 10 traditional schools.

Table 7

Participating Middle Schools: Comparison of the 2019 NYS ELA results – 8th Grade (n=22)

	Number	%
Traditional	10	45.5
PBL	12	54.5

As shown in Table 8, the 8th grade mean score on the NYS ELA for traditional schools was 595.37. The mean score on the NYS ELA for PBL schools was 609.95,

which was higher than traditional schools by 14.58 points (p = .005). Moreover, the percentage data aggregated by the 4 different levels of performance on the 8th grade NYS ELA shows similar results to that of 4th grade results. Traditional middle schools have higher percentage of both level 1 (below grade-level standards) and level 2 (approaching grade-level standards) students compared to PBL schools. It also showed that there was a significant difference in the % of Level 1 and Level 2 students between PBL and traditional schools. Interestingly, there was a very large difference shown in 8th grade between the percentage of level 4 students in traditional schools versus PBL schools with a 26.28 percent difference (p = .006). Again, the t-test analysis showed that there was a significant difference in the 8th grade ELA scores for traditional schools (M = 595.37, SD = 11.57) and PBL schools (M = 609.95, SD = 9.82) conditions; *t* (20) = -3.199, p = .005. These results suggest that approach to teaching does have on students' academic achievement in ELA in middle schools as well. Specifically, the results suggest that when schools employ PBL approach to teaching with young adolescents in middle schools (8th graders), students' academic achievement in ELA increases significantly. The results also suggest that students with higher performance levels are impacted heavily from the difference in teaching approach utilized by the teachers.

Table 8

Independent Samples T-Test: Comparison of the 2019 NYS ELA results – 8th Grade (n=22)

Levels	Traditional			PBL					
	N	Mean	SD	N	Mean	SD	*t*	df	*p*
ELA Mean	10	595.37	11.57	12	609.95	9.82	-3.199	20	.005
% Level 1	10	23.20	18.18	12	8.42	6.28	2.645	20	.016
% Level 2	10	37.17	11.55	12	23.58	11.72	2.73	20	.013
% Level 3	10	24.94	10.63	12	27.03	9.70	-.484	20	.634
% Level 4	10	14.69	12.72	12	40.97	24.26	-3.083	20	.006

Comparison of ELA academic achievement between different levels of PBL implementation.

A one-way between-subjects ANOVA test was also conducted to analyze the possible differences between schools at different implementation levels of PBL. Again, the dependent variable was the NYS ELA Test result for each school. The independent variables were the level of PBL implementation: level 1-Traditional schools that have only begun to become aware of the PBL approach to teaching and/or schools at the Beginning Stage of PBL Implementation, level 2 - School-wide Implementation of PBL, and level 3 – Full Implementation of PBL.

Hypotheses (1-way between-subjects ANOVA).

H_0 = There is no significant difference in students' achievement on NYS ELA Test between schools that are at 3 different levels of PBL implementation (Level 1-

No/Beginning PBL Implementation, Level 2-School-wide PBL Implementation, Level 3- Full School-wide PBL Implementation)

Implementation of instructional initiatives takes time and effort to impact any real changes in pedagogical practices. Therefore, I hypothesize that schools at higher PBL implementation levels will show increase in students' academic achievement in ELA, compared to schools at lower PBL implementation levels.

All schools.

As shown in Table 9, a total of 72 schools participated in this study: 41 schools at PBL Implementation level 1, 23 schools at PBL Implementation level 2, and 8 schools at PBL Implementation level 3.

Table 9

Participating Schools: Comparison of the 2019 NYS ELA results by PBL Implementation Level - All Schools (n=72)

	Number	%
PBL Implementation Level 1	41	56.9
PBL Implementation Level 2	23	31.9
PBL Implementation Level 3	8	11.1

As shown in Table 10, the mean score of schools at the PBL Implementation Level 1 scored the lowest on the NYS ELA, followed by schools at the PBL Implementation Level 2. Schools at the PBL Implementation Level 3 scored the highest with the mean value of 611.80 (which was higher than Implementation Level 2 schools by 5.95 and higher than Implementation Level 1 schools by 13.77).

The one-way between-subjects ANOVA analysis showed that there was a significant difference in students' achievement on NYS ELA Test at the $p < .01$ level for the three conditions [$F(2, 69) = 14.493$, $p = .000$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the PBL Implementation level 1 condition ($M = 598.03$, $SD = 7.83$) was significantly different than the PBL Implementation level 3 condition ($M = 611.80$, $SD = 7.64$) at the $p = .000$ level. Likewise, the mean score for the PBL Implementation level 1 condition was significantly different than the PBL Implementation level 2 condition ($M = 605.85$, $SD = 7.73$) at the $p = .001$ level. However, the mean score for PBL Implementation level 2 was not significantly different than the PBL Implementation level 3 ($p = .156$). Taken together, the results suggest, not only that the PBL approach to teaching has more impact on students' academic achievement than traditional teaching approach, but also that the stronger the PBL implementation level in the school, the higher the ELA academic outcomes (Figure 1).

Figure 2

Changes in NYS ELA Scale Score as a Function of PBL Implementation Level

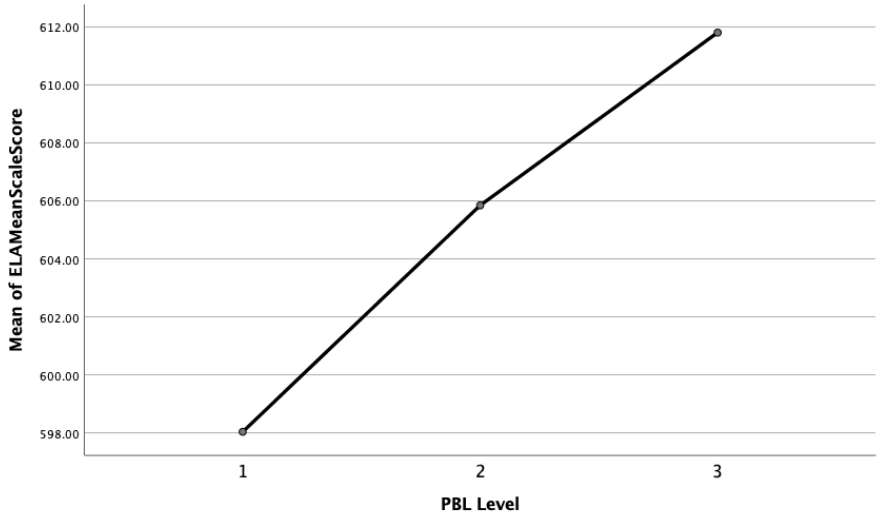


Table 10

One-way between-Subjects ANOVA: Comparison of the 2019 NYS ELA results by PBL Implementation Level - All Schools (n=72)

Levels	PBL Impl. Level 1			PBL Impl. Level 2			PBL Impl. Level 3					
	N	Mean	SD	N	Mean	SD	N	Mean	SD	df	F	*p*
ELA Mean	41	598.03	7.83	23	605.85	7.73	8	611.80	7.64	(2, 69)	14.493	.000
% Level 1	41	21.33	12.17	23	10.99	6.09	8	6.8960	6.16	(2, 69)	11.784	.000
% Level 2	41	32.76	8.16	23	27.37	10.19	8	18.26	10.47	(2, 69)	9.360	.000
% Level 3	41	29.02	9.85	23	33.04	7.56	8	29.44	8.62	(2, 69)	1.501	.230
% Level 4	41	16.89	10.11	23	28.60	17.65	8	45.40	19.75	(2, 69)	15.694	.000

4th grade.

As shown in Table 11, a total of 50 elementary schools participated in this study: 31 elementary schools at PBL Implementation level 1, 16 elementary schools at PBL Implementation level 2, and 3 elementary schools at PBL Implementation level 3.

Table 11

Participating Elementary Schools: Comparison of the 2019 NYS ELA results by PBL Implementation Level – 4th Grade (n=50)

	Number	%
PBL Implementation Level 1	31	62
PBL Implementation Level 2	16	32
PBL Implementation Level 3	3	6

As shown in Table 12, the mean score of elementary schools at the PBL Implementation Level 1 scored the lowest on the NYS ELA, followed by elementary schools at the PBL Implementation Level 2. Elementary schools at the PBL Implementation Level 3 scored the highest with the mean value of 613.73 (which was higher than Implementation Level 2 schools by 9.03 and higher than Implementation Level 1 schools by 14.84).

The one-way between-subjects ANOVA analysis showed that there was a significant difference in students' achievement on 4th grade NYS ELA Test at the $p < .01$ level for the three conditions [$F(2, 47) = 11.005$, $p = .000$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the elementary school PBL Implementation level 1 condition ($M = 598.89$, $SD = 6.195$) was significantly different

than the elementary school PBL Implementation level 3 condition (M = 613.73, SD = 5.36) at the p = .000 level. Likewise, the mean score for the elementary school PBL Implementation level 1 condition was significantly different than the PBL elementary school Implementation level 2 condition (M = 604.27, SD = 5.54) at the p = .014 level. In addition, for elementary schools, the mean score for PBL Implementation level 2 was also significantly different than the PBL Implementation level 3 (p = .039). Taken together, the results suggest once again that more in-depth, comprehensive school-wide Implementation of the PBL approach to teaching impacts young elementary students' academic achievement in more profound ways. Figure 2 below shows the clear positive relationship between the level of PBL implementation in the school and 4th grade students' academic achievement in ELA.

Figure 3

Changes in NYS ELA Scale Score as a Function of PBL Implementation Level- 4th Grade

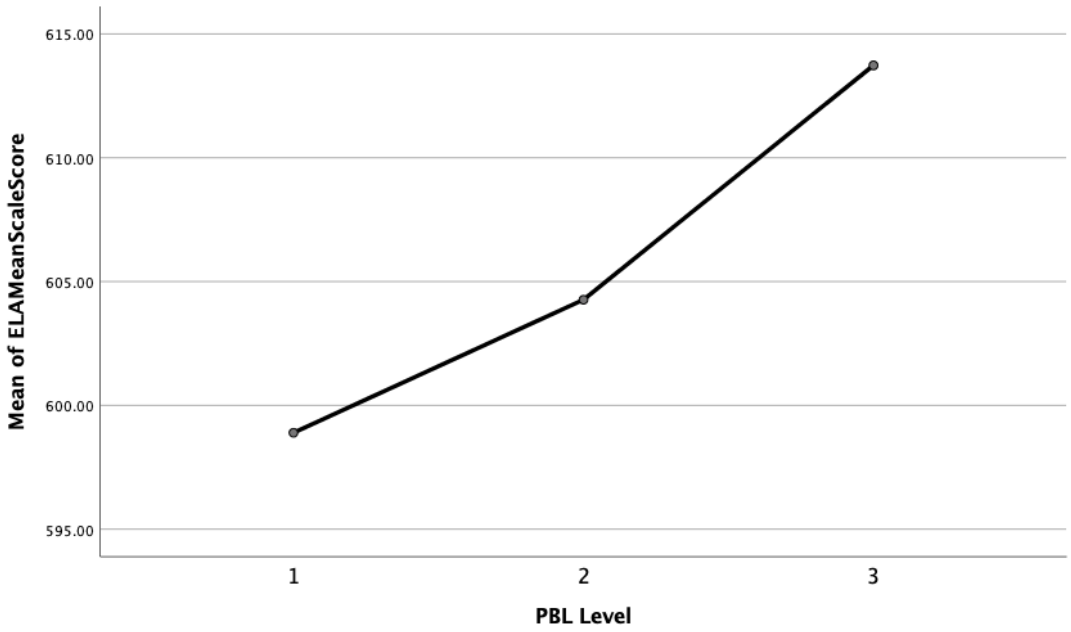


Table 12

One-way between-Subjects ANOVA: Comparison of the 2019 NYS ELA results by PBL Implementation Level – 4th Grade (n=50)

Levels	PBL Impl. Level 1			PBL Impl. Level 2			PBL Impl. Level 3					
	N	Mean	SD	N	Mean	SD	N	Mean	SD	df	F	*p*
ELA Mean	31	598.89	6.195	16	604.27	5.54	3	613.73	5.36	(2, 47)	11.005	.000
% Level 1	31	20.72	9.83	16	11.91	6.01	3	5.43	5.19	(2, 47)	8.373	.001
% Level 2	31	31.34	6.34	16	28.26	9.36	3	13.48	7.92	(2, 47)	7.964	.001
% Level 3	31	30.33	9.39	16	35.39	4.38	3	34.92	3.58	(2, 47)	2.333	.108
% Level 4	31	17.60	9.26	16	24.44	11.45	3	46.17	13.56	(2, 47)	11.667	.000

8th grade.

As shown in Table 13, a total of 22 middle schools participated in this study: 10 middle schools at PBL Implementation level 1, 7 middle schools at PBL Implementation level 2, and 5 middle schools at PBL Implementation level 3.

Table 13

Participating Middle Schools: Comparison of the 2019 NYS ELA results by PBL Implementation Level – 8th Grade (n=22)

	Number	%
PBL Implementation Level 1	10	45.5
PBL Implementation Level 2	7	31.8
PBL Implementation Level 3	5	22.7

As shown in Table 14, the mean score of middle schools at the PBL Implementation Level 1 scored the lowest on the NYS ELA, followed by middle schools at the PBL Implementation Level 2. Middle schools at the PBL Implementation Level 3 scored the highest with the mean value of 610.65 (which was higher than Implementation Level 2 schools by 1.2 and higher than Implementation Level 1 schools by 15.28).

The one-way between-subjects ANOVA analysis showed that there was a significant difference in students' achievement on 8th grade NYS ELA Test at the $p < .05$ level for the three conditions [$F(2, 19) = 4.887$, $p = .019$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the middle schools PBL Implementation level 1 condition ($M = 595.37$, $SD = 11.57$) was significantly different than the middle schools PBL Implementation level 3 condition ($M = 610.65$, $SD = 9.12$)

at the p = .048 level. Likewise, the mean score for the middle school PBL Implementation level 1 condition was significantly different than the PBL middle school implementation level 2 condition (M = 609.45, SD = 10.99) at the p = .043 level. On the other hand, for middle schools, the mean score for PBL implementation level 2 was not significantly different than the PBL implementation level 3 (p = .981). The ANOVA analysis from the middle school data confirms previous data analysis from elementary school data, which show a strong correlation between the level of PBL implementation in the school and students' academic achievement in ELA. This strong positive relationship is an encouraging finding that could empower educators to reflect on our current practices and to make shifts to provide students with more PBL opportunities that may support students' academic achievement, especially for lower performing and high achieving students (where the largest impact was seen). Figure 3 below shows the clear positive relationship between the level of PBL implementation in the school and 8th grade students' academic achievement in ELA.

Figure 4

Changes in NYS ELA Scale Score as a Function of PBL Implementation Level- 8th Grade

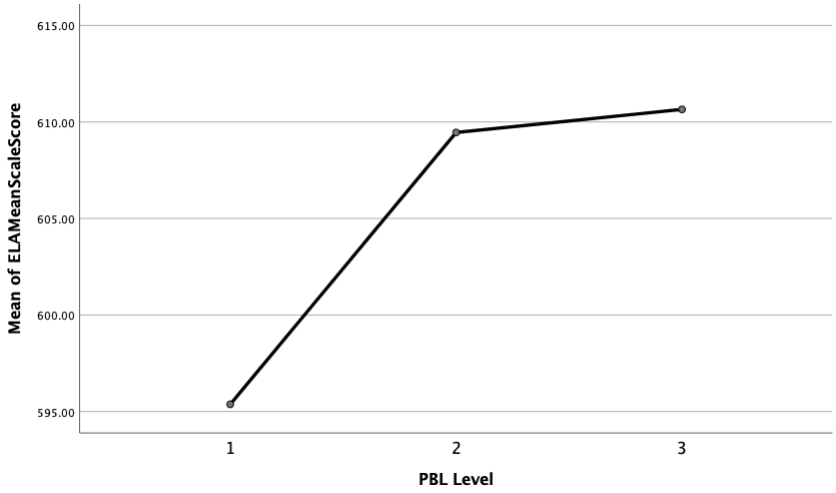


Table 14

One-way between-Subjects ANOVA: Comparison of the 2019 NYS ELA results by PBL Implementation Level – 8th Grade (n=22)

Levels	PBL Impl. Level 1			PBL Impl. Level 2			PBL Impl. Level 3					
	N	Mean	SD	N	Mean	SD	N	Mean	SD	df	F	*p*
ELA Mean	10	595.37	11.57	7	609.45	10.99	5	610.65	9.12	(2, 19)	4.887	.019
% Level 1	10	23.20	18.18	7	8.87	6.18	5	7.77	7.09	(2, 19)	3.336	.057
% Level 2	10	37.17	11.55	7	25.33	12.43	5	21.13	11.54	(2, 19)	3.782	.041
% Level 3	10	24.94	10.63	7	27.66	10.63	5	26.15	9.35	(2, 19)	.142	.868
% Level 4	10	14.69	12.72	7	38.13	25.75	5	44.95	24.29	(2, 19)	4.758	.021

Research question 2

Will there be significant differences in students' achievement on the 4th and 8th grade NYS Mathematics Test between schools that employed PBL approach and schools that employed traditional teaching approach?

Comparison of math academic achievement by type of teaching approach.

To compare students' achievement on the 4th and 8th grade NYS Mathematics Test between schools that employed PBL approach and schools that employed traditional teaching approach, an independent samples T-test was conducted to test for statistically significant difference between the two groups (similar to the method used for NYS ELA). In this study, the dependent variable was the NYS Mathematics Test result for each school. The independent variable was the type of teaching approach: PBL or traditional.

Hypotheses (Independent Samples T-test).

H_0 = There is no significant difference in students' achievement on NYS Mathematics Test between schools that employed PBL approach and schools that employed traditional teaching approach.

As stated before, PBL approach promotes a learning environment that supports high expectations for students, as well as a communicative and collaborative learning environment. Mathematics, being a critical content area where the conceptual understanding and problem-solving skills are reciprocal skills & knowledge that need to be cultivated simultaneously in a dynamic learning environment, I hypothesize PBL schools will show higher academic achievement in mathematics.

All schools.

As shown in Table 15, although a total of 72 schools participated in this study, only 65 schools' 2019 NYS Mathematics Test data was available for the study. Out of the 65 schools, 26 schools were PBL schools and 39 schools were traditional schools.

Table 15

Participating Schools: Comparison of the 2019 NYS Math results – All Schools (n=65)

	Number	%
Traditional	39	60
PBL	26	40

As shown in Table 16, the mean score on the NYS Mathematics for traditional schools was 598.73. The mean score on the NYS Mathematics for PBL schools was 608.86, which was higher than traditional schools by 10.13 points (p = .000). Moreover, the percentage data aggregated by the 4 different levels of performance on the NYS ELA shows that traditional schools have higher percentage of both level 1 (below grade-level standards) and level 2 (approaching grade-level standards) students compared to PBL schools. It also showed that there was a significant difference in the % of Level 1 and Level 2 students between PBL and traditional schools. The largest difference shown was between the percentage of level 4 students in PBL schools versus traditional schools with a 16.05 percent difference (p = .000). The t-test analysis showed that there was a significant difference in the ELA scores for traditional schools (M = 598.03, SD = 7.83) and PBL schools (M = 607.38, SD = 8.03) conditions; *t* (70) = - 4.963, p = .000. These

results suggest that PBL approach to teaching has a large effect on students' academic achievement in mathematics. The results suggest that when schools employ PBL approach to teaching, students' academic achievement in mathematics also increases significantly.

Table 16

Independent Samples T-Test: Comparison of the 2019 NYS Math Results - All Schools (n=65)

Levels	Traditional			PBL					
	N	Mean	SD	N	Mean	SD	*t*	df	*p*
Math Mean	39	598.73	8.54	26	608.86	9.57	-4.461	63	.000
% Level 1	39	29.44	18.21	26	17.16	17.16	2.724	63	.008
% Level 2	39	28.83	8.80	26	21.43	11.20	2.974	63	.004
% Level 3	39	19.54	8.28	26	22.54	6.18	-1.575	63	.120
% Level 4	39	22.19	14.90	26	38.86	19.72	-3.879	63	.000

4th grade.

The results of the 2019 Grade 4 NYS Mathematics Test were analyzed for 49 elementary schools: 19 PBL schools and 30 traditional schools.

Table 17

Participating Elementary Schools: Comparison of the 2019 NYS Math results – 4th Grade (n=49)

	Number	%
Traditional	30	61.2
PBL	19	38.8

As shown in Table 18, the 4th grade mean score on the NYS Math for traditional schools was 599.88. The mean score on the NYS Math for PBL schools was 609.19, which was higher than traditional schools by 9.31 points (p = .001). Moreover, the percentage data aggregated by the 4 different levels of performance on the 4th grade NYS Math shows that again, traditional schools have a significantly higher percentage of level 1 (below grade-level standards) students compared to PBL schools (p = .003). Conversely, PBL schools have a significantly higher percentage of level 4 (above grade-level standards) students compared to traditional schools (p = .001). The t-test analysis showed that there was a significant difference in the 4th grade ELA scores for traditional schools (M = 599.88, SD = 8.00) and PBL schools (M = 609.19, SD = 9.37) conditions; *t* (48) = -3.729, p = .001. These results, again, suggest that approach to teaching does have an effect on students' academic achievement in mathematics. The results suggest that when schools employ PBL approach to teaching with elementary students, in this case, 4th graders, students' academic achievement in mathematics increases significantly. The impact of the PBL approach also seem to be most significant with the lowest and the highest performing students.

Table 18

Independent Samples T-Test: Comparison of the 2019 Math results – 4th Grade (n=49)

Levels	Traditional			PBL					
	N	Mean	SD	N	Mean	SD	*t*	df	*p*
Math Mean	30	599.88	8.00	19	609.19	9.37	-3.729	48	.001
% Level 1	30	23.53	13.54	19	12.76	8.52	3.095	48	.003
% Level 2	30	28.50	9.02	19	22.61	11.53	1.999	48	.051
% Level 3	30	22.07	7.19	19	21.50	4.20	.308	48	.759
% Level 4	30	25.90	14.20	19	43.13	19.89	-3.537	48	.001

8th grade.

As shown in Table 19, a total of 22 schools participated in this study: 12 PBL schools and 10 traditional schools.

Table 19

Participating Middle Schools: Comparison of the 2019 NYS Math results – 8th Grade (n=16)

	Number	%
Traditional	9	56.3
PBL	7	43.7

As shown in Table 20, the 8th grade mean score on the NYS Math for traditional schools was 594.90. The mean score on the NYS ELA for PBL schools was 607.96,

which was higher than traditional schools by 13.06 points ($p < .05$). Moreover, the percentage data aggregated by the 4 different levels of performance on the 8th grade NYS Math showed that traditional middle schools had significantly higher percentage of level 2 students ($p < .05$), while PBL middle schools had significantly higher percentage of level 3 students ($p = .003$) and level 4 students ($p < .05$). Again, the t-test analysis showed that there was a significant difference in the 8th grade ELA scores for traditional schools ($M = 594.90$, $SD = 9.62$) and PBL schools ($M = 607.96$, $SD = 11.08$) conditions; $t(14) = -2.522$, $p < .05$. These results suggest that approach to teaching does have on students' academic achievement in Math in middle schools as well. Specifically, the results suggest that when schools employ PBL approach to teaching with young adolescents in middle schools (8th graders), students' academic achievement in Math also increases significantly.

Table 20

Independent Samples T-Test: Comparison of the 2019 Math results – 8th Grade (n=16)

Levels	Traditional			PBL					
	N	Mean	SD	N	Mean	SD	*t*	df	*p*
Math Mean	9	594.90	9.62	7	607.96	11.08	-2.522	14	.024
% Level 1	9	49.13	18.52	7	29.11	27.96	1.723	14	.107
% Level 2	9	29.93	8.45	7	18.25	10.37	2.487	14	.026
% Level 3	9	11.14	5.85	7	25.35	9.69	-3.650	14	.003
% Level 4	9	9.81	9.99	7	27.28	14.80	-2.823	14	.014

Comparison of math academic achievement between different levels of PBL implementation.

A one-way between-subjects ANOVA test was also conducted to analyze the possible differences between schools at different implementation levels of PBL on students' mathematics achievement. The dependent variable was the NYS Math Test result for each school. The independent variables were the level of PBL implementation: level 1-Traditional schools that have only begun to become aware of the PBL approach to teaching and/or schools at the Beginning Stage of PBL Implementation, level 2 - School-wide Implementation of PBL, and level 3 – Full Implementation of PBL.

Hypotheses (one-way between-subjects ANOVA).

H_0 = There is no significant difference in students' achievement on NYS Math Test between schools that are at 3 different levels of PBL implementation (Level 1-No/Beginning PBL Implementation, Level 2-School-wide PBL Implementation, Level 3- Full School-wide PBL Implementation)

I hypothesize that schools at higher PBL implementation levels will show increase in students' academic achievement in Math, compared to schools at lower PBL implementation levels.

All schools.

As shown in Table 21, a total of 72 schools participated in this study: 41 schools at PBL Implementation level 1, 23 schools at PBL Implementation level 2, and 8 schools at PBL Implementation level 3.

Table 21

Participating Schools: Comparison of the 2019 NYS Math results by PBL Implementation Level - All Schools (n=65)

	Number	%
PBL Implementation Level 1	39	60
PBL Implementation Level 2	21	32.3
PBL Implementation Level 3	5	7.7

As shown in Table 22, the mean score of schools at the PBL Implementation Level 1 scored the lowest on the NYS Math, followed by schools at the PBL Implementation Level 2. Schools at the PBL Implementation Level 3 scored the highest with the mean value of 615.53, which was higher than Implementation Level 2 schools by 8.27 and higher than Implementation Level 1 schools by 16.8 ($p = .000$).

The one-way between-subjects ANOVA analysis showed that there was a significant difference in students' achievement on NYS Math Test at the $p < .01$ level for the three conditions [$F (2, 62) = 12.143$, $p = .000$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the PBL Implementation level 1 condition ($M = 598.73$, $SD = 8.54$) was significantly different than the PBL Implementation level 3 condition ($M = 615.53$, $SD = 5.60$) at the $p = .000$ level. Likewise, the mean score for the PBL Implementation level 1 condition was significantly different than the PBL Implementation level 2 condition ($M = 607.26$, $SD = 9.72$) at the $p = .002$ level. However, the mean score for PBL Implementation level 2 was not significantly different than the PBL Implementation level 3 ($p = .150$). Taken together, the results suggest, not

only that the PBL approach to teaching has more impact on students' academic achievement than traditional teaching approach, but also that the stronger the PBL implementation level in the school, the higher the outcomes for mathematics achievement (See Figure 4).

Figure 5

Changes in Math Scale Score as a Function of PBL Implementation Level

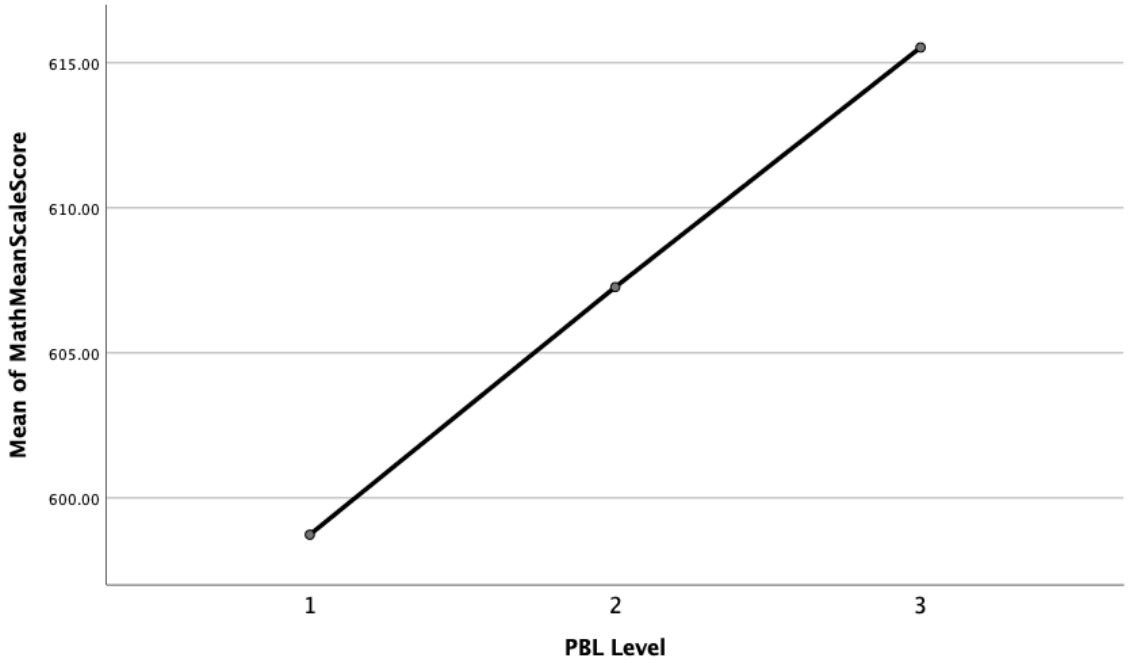


Table 22

One-way between-Subjects ANOVA: Comparison of the 2019 Math results by PBL Implementation Level - All Schools (n=65)

Levels	PBL Impl. Level 1			PBL Impl. Level 2			PBL Impl. Level 3					
	N	Mean	SD	N	Mean	SD	N	Mean	SD	df	F	*p*
Math Mean	39	598.73	8.54	21	607.26	9.72	5	615.53	5.60	(2, 62)	12.143	.000
% Level 1	39	29.44	18.21	21	18.33	18.21	5	12.28	12.10	(2, 62)	3.909	.025
% Level 2	39	28.83	8.80	21	23.29	11.27	5	13.65	7.38	(2, 62)	6.673	.002
% Level 3	39	19.54	8.28	21	22.83	6.22	5	21.34	6.57	(2, 62)	1.302	.279
% Level 4	39	22.19	14.90	21	35.56	18.06	5	52.73	22.41	(2, 62)	10.099	.000

4th grade.

As shown in Table 23, a total of 49 elementary schools participated in this study: 30 elementary schools at PBL Implementation level 1, 16 elementary schools at PBL Implementation level 2, and 3 elementary schools at PBL Implementation level 3.

Table 23

Participating Elementary Schools: Comparison of the 2019 NYS Math results by PBL Implementation Level – 4th Grade (n=49)

	Number	%
PBL Implementation Level 1	30	61.2
PBL Implementation Level 2	16	32.7
PBL Implementation Level 3	3	6.1

As shown in Table 24, the mean score of elementary schools at the PBL Implementation Level 1, once again, scored the lowest on the NYS Math, followed by elementary schools at the PBL Implementation Level 2. Elementary schools at the PBL Implementation Level 3 scored the highest with the mean value of 618.65 (which was higher than Implementation Level 2 schools by 11.24 and higher than Implementation Level 1 schools by 18.77).

The one-way between-subjects ANOVA analysis showed that there was a significant difference in students' achievement on 4th grade NYS Math Test at the $p < .01$ level for the three conditions [$F(2, 46) = 9.887$, $p = .000$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the elementary school PBL

Implementation level 1 condition (M = 599.88, SD = 8.00) was significantly different than the elementary school PBL Implementation level 3 condition (M = 618.65, SD = 4.42) at the p = .001 level. Likewise, the mean score for the elementary school PBL Implementation level 1 condition was significantly different than the PBL elementary school Implementation level 2 condition (M = 607.41, SD = 8.90) at the p = .013 level. However, for elementary schools, the mean score for PBL Implementation level 2 was not significantly different than the PBL Implementation level 3 (p = .085). The results suggest, once again, that more in-depth, comprehensive, school-wide implementation of the PBL approach to teaching impacts young elementary students' academic achievement in profound ways. The results also suggest that the impact is greater on both ends of the spectrum with math performance level 1 students and with math performance level 4 students. Figure 5 below shows positive relationship between the level of PBL implementation in the school and 4th grade students' academic achievement in Math.

Figure 6

Changes in Math Scale Score as a Function of PBL Implementation Level- 4th Grade

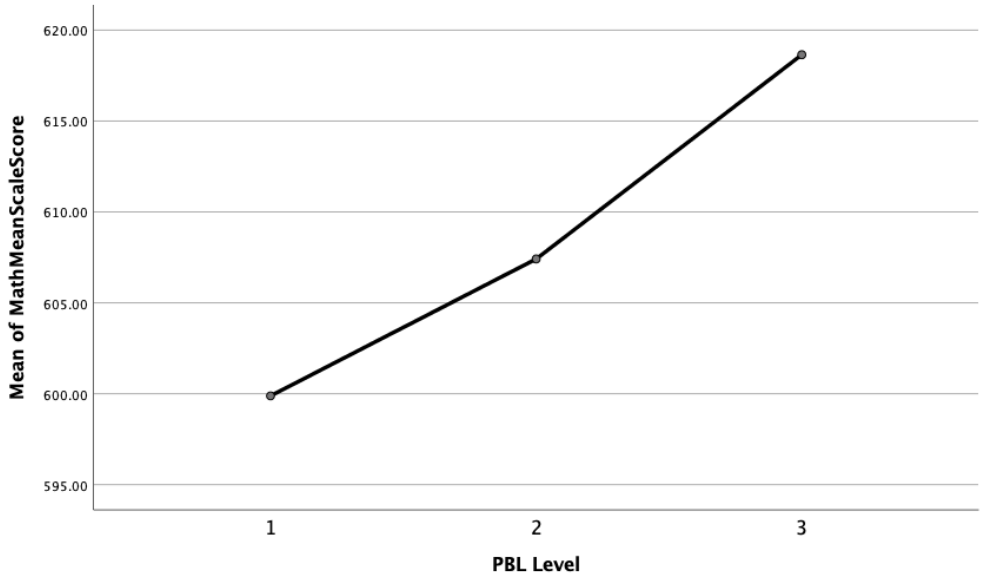


Table 24

One-way between-Subjects ANOVA: Comparison of the 2019 Math results by PBL Implementation Level – 4th Grade (n=49)

Levels	PBL Impl. Level 1			PBL Impl. Level 2			PBL Impl. Level 3					
	N	Mean	SD	N	Mean	SD	N	Mean	SD	df	F	*p*
Math Mean	30	599.88	8.00	16	607.41	8.90	3	618.65	4.42	(2, 46)	9.887	.000
% Level 1	30	23.53	13.54	16	14.44	8.07	3	3.79	4.66	(2, 46)	5.941	.005
% Level 2	30	28.50	9.02	16	24.74	11.06	3	11.20	6.90	(2, 46)	4.652	.014
% Level 3	30	22.07	7.19	16	21.92	3.32	3	19.29	8.12	(2, 46)	.269	.765
% Level 4	30	25.90	14.20	16	38.90	17.65	3	65.72	17.76	(2, 46)	10.869	.000

8th grade.

As shown in Table 25, a total of 16 middle schools participated in this study: 9 middle schools at PBL Implementation level 1, 5 middle schools at PBL Implementation level 2, and 2 middle schools at PBL Implementation level 3.

Table 25

Participating Middle Schools: Comparison of the 2019 NYS Math results by PBL Implementation Level – 8th Grade (n=16)

	Number	%
PBL Implementation Level 1	9	56.3
PBL Implementation Level 2	5	31.3
PBL Implementation Level 3	2	12.5

Interestingly, as shown in Table 26, the one-way between-subjects ANOVA analysis did not yield any significant difference in students' achievement on 8th grade NYS Math Mean Scale Scores between different PBL implementation levels ($p = .079$). Although not statistically significant, a review of the means plot (Figure 6) does illustrate a positive relationship between NYS Math Scores and PBL Implementation Levels. Moreover, further analysis indicated that there is a significant difference in the percentage of students achieving level 3 and level 4 on the 8th grade NYS Math Test. The difference in the percentage of students achieving level 3 on the NYS Math was at the $p < .05$ level for the three conditions [$F (2, 13) = 6.223$, $p = .013$]. Likewise, the difference in the percentage of students achieving level 4 on the NYS Math was at the $p < .05$ level for

the three conditions [F (2, 13) = 4.204, p = .039]. The ANOVA analysis from the middle school data showed that while the relationship between the PBL implementation levels and students' achievement on the NYS Mathematics Test (based on the Mean Scale Scores) was not significant, there was still a statistically significant positive relationship between implementation levels and the percentage of students achieving higher scores of level 3 and level 4 on the NYS Math. This finding suggests that as students move to higher grade levels (middle school) and the complexity of the mathematics content material increases, the level of PBL implementation may have a greater impact on higher levels of performance. The strong positive relationship between both the type of teaching approach, namely PBL, and the level of PBL implementation, on students' academic achievement in mathematics and ELA are encouraging findings, nevertheless. To close the achievement gap that persists in our schools, we must continue to reflect on our current practices and to make shifts to provide students with more opportunities for students to develop critical thinking and problem-solving skills by employing teaching approaches, such as PBL, that indicate a stong positive academic outcomes for all students.

Figure 7

Changes in Math Scale Score as a Function of PBL Implementation Level- 8th Grade

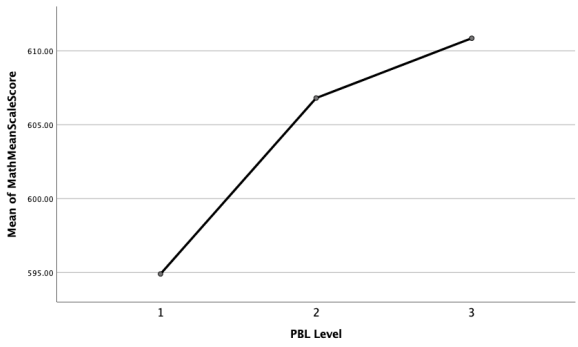


Table 26

One-way between-Subjects ANOVA: Comparison of the 2019 Math results by PBL Implementation Level – 8th Grade (n=16)

Levels	PBL Impl. Level 1			PBL Impl. Level 2			PBL Impl. Level 3					
	N	Mean	SD	N	Mean	SD	N	Mean	SD	df	F	*p*
Math Mean	9	594.90	9.62	5	606.80	13.23	2	610.85	3.67	(2, 13)	3.104	.079
% Level 1	9	49.13	18.52	5	30.75	34.07	2	25.02	1.28	(2, 13)	1.429	.275
% Level 2	9	29.93	8.45	5	18.62	11.89	2	17.34	8.80	(2, 13)	2.890	.092
% Level 3	9	11.14	5.85	5	25.74	11.73	2	24.40	3.08	(2, 13)	6.223	.013
% Level 4	9	9.81	9.99	5	24.90	16.60	2	33.25	10.60	(2, 13)	4.204	.039

Research question 3

Will there be significant differences in the subcategories of the NYC School Survey, Quality of Student Discussion & Supportive Environment with High Expectations, between schools that employed PBL teaching approach and schools that employed traditional teaching approach?

Differences in the subcategories of the NYC School Survey between PBL schools and traditional schools.

To compare the school and classroom learning environment between schools that employed PBL approach and schools that employed traditional teaching approach, ANOVA was conducted to test for significant differences in the subcategories of the NYC School Survey - Quality of Student Discussion & Supportive Environment with High Expectations, between schools that employed PBL approach to teaching and schools that employed traditional approach to teaching. The independent variables was the type of teaching approach (PBL or traditional), and dependent variables were the level of positive responses regarding the Quality of Student Discussion and the level of positive responses regarding the level of expectations and supports in the classroom - subcategory of the NYC School Survey - Supportive Environment with High Expectations. For the purposes of this study, the subcategory, Supportive Environment – Social-emotional, was renamed as Supportive Environment with High Expectations to accurately reflect the types of questions surveyed.

Hypotheses (one-way between-subjects ANOVA).

H_0 = There are no significant difference in the NYC School Survey score for Quality of Student Discussion & Supportive Environment with High Expectations between schools employing different types of teaching approach (PBL & traditional).

As shown in the literature review, the quality of student discussions in the classroom and the development of a supportive classroom environment is strongly connected to the way instruction is delivered. Therefore, I hypothesize that there will be significant differences in the subcategories of the NYC School Survey, Quality of Student Discussion & Supportive Environment with High Expectations, between schools that employed PBL teaching approach and schools that employed traditional teaching approach.

As shown in Table 27, a total of 72 schools participated in this study: 41 traditional and 31 PBL.

Table 27

Participating Schools: Differences in the NYC School Survey scores between PBL Schools & Traditional Schools – All Schools (n=72)

	Number	%
Traditional	41	56.9
PBL	31	43.1

The descriptive statistics for the ANOVA analysis indicated a higher mean score for both Quality of Student Discussions and Supportive Environment with High Expectations for PBL schools, when compared to traditional schools (Table 28).

Table 28

Descriptives: Differences in the NYC School Survey scores between PBL Schools & Traditional Schools (n=72)

	Traditional			PBL		
	N	Mean	SD	N	Mean	SD
Quality of Student Discussions	41	3.08	1.01	31	3.92	.46
Supp. Env. with High Expectations	41	3.26	.86	31	3.72	.66

As shown is Table 29, the one-way between-subjects ANOVA analysis indicated that there was a significant difference in the Quality of Student Discussions scores between PBL schools and traditional schools at the $p < .01$ level for the condition [$F (1, 70) = 18.558$, $p = .000$]. Likewise, the ANOVA analysis showed that there was also a significant difference in the Supportive Environment with High Expectations scores between PBL schools and traditional schools at the $p < .05$ level for the condition [$F (1, 70) = 6.112$, $p = .016$].

Table 29

ANOVA: Differences in the NYC School Survey scores between PBL Schools & Traditional Schools (n=72)

		df	F	*p*
Quality of Student Discussions				
	Between Groups	1	18.558	.000
	Within Groups	70		
Supportive Environment with High Expectations				
	Between Groups	1	6.112	.016
	Within Groups	70		

The results suggest that there, indeed, is a strong correlation between the type of teaching approach employed by schools/classrooms to the quality of the learning environment that is produced. As literature review suggests, PBL approach to teaching is strongly correlated to an increase in the quality of student discussions, as well as the level of high expectations and supports promoted in the classroom.

Research question 4

Which predictors, teaching approach (PBL vs. traditional), supportive environment of high expectations, and quality of student discussion, predict students' achievement in ELA and Mathematics significantly?

Lastly, to examine which variables, teaching approach (PBL vs. traditional), supportive environment of high expectations, and/or quality of student discussion, predict students' achievement in ELA and Mathematics significantly, a regression analysis was conducted.

Hypotheses (Multiple Regression Analysis).

H_0 = There will be no significant prediction of NYS ELA achievement by teaching approach, supportive environment of high expectations, and the quality of student discussions.

H_0 = There will be no significant prediction of NYS Math achievement by teaching approach, supportive environment of high expectations, and quality of student discussions.

As shown in the literature review, the quality of student discussions in the classroom and the development of a supportive classroom environment is strongly connected to the way instruction is delivered, which likely presents an optimal learning environment that promote academic achievement. Therefore, I hypothesize that there will be significant predictions of both NYS ELA and NYS Math scores by teaching approach, supportive environment, and the quality of students' discussions.

NYS ELA.

In order to test the above hypothesis, a stepwise multiple regression analysis was conducted. A stepwise multiple regression analysis was conducted to predict the NYS ELA achievement based on teaching method, supportive environment of high expectations, and the quality of student discussions.

The results of the regression indicated that the model explained 36.6% of the variance ($R^2 = .366$) and that the model was a significant predictor of ELA achievement, $F (3, 68) = 13.077$, $p < .000$. Figure 7 illustrates this relationship. Schools' predicted NYS

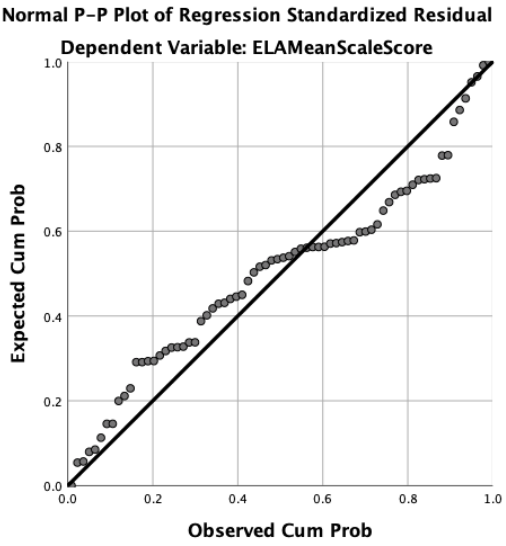
ELA achievement = 584.141 -2.033 (SEHE) + 4.566 (QSD) + 6.452 (Type)

where Supportive Environment of High Expectations (SEHE) and Quality of Student Discussions (QSD) are measured in points, and the teaching approach (Type) are coded as 1 = Traditional, 2 = PBL. Schools' NYS ELA achievement increased 4.566 points for every point of QSD and PBL schools scored 6.452 points more than traditional schools. Quality of Student Discussions contributed significantly to the model (B =

4.566, p < .01). Teaching approach (Type) also contributed significantly to the model (B = 6.452, p < .01). On the other hand, Supportive Environment of High Expectations (SEHE) did not contribute significantly to the model (B = -2.033, p = .173). In other words, teaching approach and the quality of student discussions in the classroom were significant predictors of ELA achievement, but the supportive environment was not a significant predictor.

Figure 8

Normal P – P Plot of Regression: NYS ELA



NYS Mathematics.

In order to test the above hypothesis for the NYS Mathematics test, an additional multiple regression analysis was conducted. A multiple regression analysis was conducted to predict the NYS Math achievement based on teaching method, supportive environment of high expectations, and the quality of student discussions.

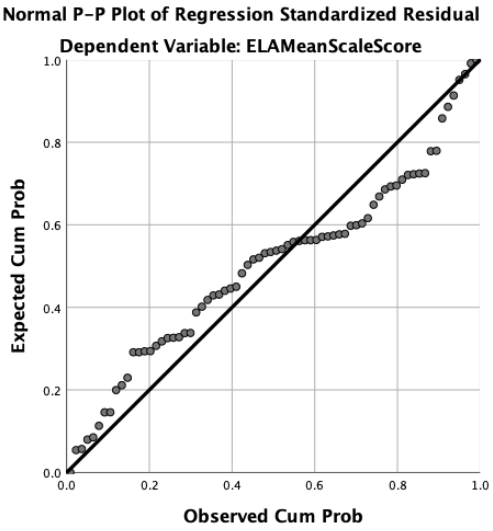
The results of the regression indicated that the model explained 42.6% of the variance (R^2 = .426) and that the model was a significant predictor of Math achievement, F (3, 61) = 15.115, p < .000. Figure 8 illustrates this relationship. Schools' predicted

NYS Math achievement = 577.724 -.355 (SEHE) + 5.422 (QSD) + 5.598 (Type),

where Supportive Environment of High Expectations (SEHE) and Quality of Student Discussions (QSD) are measured in points, and the teaching approach (Type) are coded as 1 = Traditional, 2 = PBL. Schools' NYS Math achievement increased 5.422 points for every point of QSD and PBL schools scored 5.598 points more than traditional schools. Quality of Student Discussions contributed significantly to the model (B = 5.422, p < .001). Teaching approach (Type) also contributed significantly to the model (B = 5.598, p < .05). On the other hand, Supportive Environment of High Expectations (SEHE), again, did not contribute significantly to the model (B = -.355, p = .825). In other words, teaching approach and the quality of student discussions in the classroom were significant predictors of Math achievement, but the supportive environment was not a significant predictor.

Figure 9

Normal P – P Plot of Regression: NYS Math



This chapter reviewed the results of the T-Test, ANOVA, and Multiple Regression analysis conducted to explore the four stated research questions. Overall, there were very positive and encouraging findings that support a strong connection between Project-based learning approach to teaching and learning and students' academic achievement. The differences in students' achievement of the 4th and 8th grade NYS ELA and NYS Math between schools that employed PBL approach and schools that employed traditional approach were statistically significant for both 4th and 8th grades, as well as for both ELA and Mathematics. There were also significant differences in the Quality of Student Discussions and & Supportive Environment with High Expectations between schools that employed PBL teaching approach and schools that employed traditional teaching approach. In addition, the teaching approach, as well as the Quality of Student Discussions, were also found to be significant predictors of students' academic achievement in NYS ELA and NYS Mathematics standardized exams. The following

chapter describes the implications of the findings, relationship to prior research, limitations of the study, recommendations for future research, and recommendations for future practice.

CHAPTER 5

Discussion

Summary of the Study

Educators have always understood the importance of developing students' creativity and problem-solving skills in our classrooms and schools. However, despite this personal understanding, the instructional practices prevalent in our public schools today provide a very different picture. Even with the growing concern and urgency we have for our children to develop the 21st century skills necessary to be competitive in our global society, much of the content continues to be taught in isolation, employing instructional approaches that emphasize students' factual and procedural knowledge. This misalignment hinders many of our students from developing critical minds and problem-solving skills, which then limits our students from being fully prepared to meet the demands of an ever-changing global market. Unfortunately, the state of our education is also contributing to the growing disparity between performance outcomes of low-income communities to middle-high income communities. In addition, the achievement gap that between different ethnic groups also stubbornly continues to persist under the current conditions in our schools.

As a result, some of our schools have begun to explore project-based learning, a dynamic instructional approach, in which students explore and solve real-world problems and/or challenges over time. To contribute to this trend, this study examined schools that emphasize the development of students' problem-solving skills by employing project-based learning (PBL) as a core method of instruction, and its impact on students' academic achievement in English Language Arts and in mathematics. This study also

examined the impact of the different approaches of instruction on the schools' learning environment, which undoubtedly is one of the most important factors affecting student learning in our schools today. In addition, Critical Race Theory (CRT) was explored in the literature review of this study as a theoretical framework for understanding the lasting impact that different approaches to teaching and learning may have on students of color in urban communities. Finding new pathways to reach students of color, who continue to combat multiple layers of disadvantages, is critical to closing the achievement gap that is so persistent in our schools. Project-based learning was explored in this study, not only as a possible pathway to expand the opportunity for our students to develop creativity and problem-solving skills necessary in the 21st century, but also with the lens of exploring PBL as a viable option that can move our current instructional pedagogy towards a more culturally relevant practice that may better support our students of color.

Research Questions.

Again, the purpose of this study is to explore the connection between the instructional approach for developing students' creativity and problem-solving skills and academic achievement by comparing students' achievement on the 4th and 8th grade NYS ELA and Math Test between schools that employ project-based learning approach as the core method of instruction versus schools which employ traditional instruction approach. Students' data on the 4th and 8th grade NYS ELA and Math Test were also compared between PBL schools currently at a lower level of PBL implementation versus PBL schools at a higher level of PBL implementation based on the PBL School Rubric created by Buck Institute for Education. In addition, the results of the relevant sub-categories of the NYC School Survey were analyzed to explore any differences schools' learning

environment, namely the Quality of Student Discussions & the Supportive Environment with High Expectations, between schools that employed PBL teaching approach and schools that employed traditional teaching approach.

The following research questions and hypothesis were at the heart of this study:

1. Will there be significant differences in students' achievement on the 4th and 8th grade NYS ELA Test between schools that employed PBL approach and schools that employed traditional teaching approach?
2. Will there be significant differences in students' achievement on the 4th and 8th grade NYS Mathematics Test between schools that employed PBL approach and schools that employed traditional teaching approach?
3. Will there be significant differences in the subcategories of the NYC School Survey, Quality of Student Discussion & Supportive Environment with High Expectations, between schools that employed PBL teaching approach and schools that employed traditional teaching approach?
4. Which predictors, teaching method (PBL vs. traditional), supportive environment of high expectations, and quality of student discussion, predict students' achievement in ELA and Mathematics significantly?

Interpretation of Results and Implications of Findings

Introduction.

While scholars have long agreed on the importance of supporting students' creativity and problem-solving skills, not all scholars, have agreed upon one single

definition. Beghetto (2017) offers that "One way to think of creativity is constrained originality. This means that originality is constrained by the need to meet task constraints, to be meaningful, and to be useful" (p. 269). In thinking of creative skills in more practical sense, emphasizing problem-solving skills that is so critical in the 21st century, we can reimagine a vibrant classroom culture where students can be cognitively engaged, challenged, and better prepared to meet the growing demands of the competitive global society that we live in today.

Project Based Learning (PBL) is a method of instruction where "students learn by actively engaging in real-world and personally meaningful projects." (Buck Institute for Education, 2014). In this model, students construct their knowledge by working to investigate and solve an authentic and complex question and/or challenge over an extended period of time with their peers. Ayaz and Söylemez (2015) explain, "The main goals of project studies are to help students to take responsibility for their education, to develop their positive risk taking behaviour, to motivate them to cooperate with others (Bilen, 2002; Korkmaz & Kaptan, 2002; Saban, 2000). With project-based learning (PBL) approach, we aim to gain students scientific skills and parallel to that to increase students' academic achievement" (p. 257). While ample research studies illustrate the benefits of PBL, many schools and educators remain reluctant to make shifts in their instructional practices in this day of accountability. Shifting away from instructional practices that focus on factual and procedural knowledge would be stepping away from the comfort and safety of decades old practice that has proven to provide academic results, at least similar to that of the status quo. Schools are currently working under conditions of immense pressure to prove their worth, based on academic results on

standardized testing. While this immense pressure is present across all schools, it is even more profound in lower performing schools where there are additional accountability measures in place and where the stakes are even higher. Therefore, shifting away from a known practice is a risk that could result in dire situations, such as a school closure. While the reluctance to any major change in practice is understandable under the amount of pressure and risk, the consequences of schools remaining status quo is detrimental to our students who will be competing in the global world in the 21st century. Schools remaining status quo may be even more detrimental to vulnerable students that struggle with additional factors, such as poverty, housing, discrimination, disabilities, etc. This study sought, not only to support current research studies that provide many exciting examples of the benefits of PBL, but to help fill the gap in current research on the impact of PBL on students' academic achievement on standardized exams that have increasingly dominated our attention in this age of hyper-accountability. The standardized assessments that were updated in 2013, the NYS ELA and the NYS Math tests, were also assessments that increased the validity of this study since the majority of the test items assessed students' ability to engage in multi-step thinking processes and to apply their conceptual knowledge of the content within new and varied contexts. This quantitative research, which reviewed standardized data of all 72 schools in two urban school districts within the same regional area was aimed at expanding the current literature on project-based learning (PBL) and its impact on students' academic achievement by using a larger sample size, longer length of intervention, and common assessments (standardized tests) across all participating schools to measure the impact of PBL on students' academic assessment with increased reliability.

Comparison of ELA academic achievement by type of teaching approach.

The results of the Independent Samples T-test conducted to compare students' achievement on the 4th and 8th grade NYS ELA Test between PBL schools that employed PBL approach and schools that employed traditional teaching approach was statistically significant. The mean score on the NYS ELA for PBL schools (n = 29) was much higher than traditional schools (n = 43), resulting in the p value < .001. Results aggregated by the four different levels of performance on the NYS ELA showed that there was a significant difference in the percentage of Level 1 and Level 2 students between PBL and traditional schools, with traditional schools have a much higher percentage of students at lower level of academic achievement. On the other hand, the largest difference was shown between the percentage of level 4 students in PBL schools versus traditional schools (p = .000), which indicated that PBL schools had a much higher percentage of students obtaining ELA academic achievement above grade-level. While results of the Independent Samples T-Test, aggregated by 4th and 8th grade, showed similarly significant results overall, the 4th grade results showed the largest difference between the percentage of level 1 students with p < .001. Interestingly, the 8th grade results showed the largest difference between the percentage of level 4 students with p = .006. These results suggest that the approach to teaching does have a significant impact on students' academic achievement in ELA for both young elementary school students, as well as for young adolescents in middle schools. This confirms Snyder and Snyder's (2008) assertion that "actively engaging students in project-based or collaborative activities can encourage students' critical thinking development" (p. 90). The result also suggests that the impact of the PBL approach is most profound for struggling students in elementary

schools, whereas the impact of the PBL approach is most profound for high performing students in middle schools. This result may also be a reflection of the achievement gap that grows wider as children move up in their grade levels. Alternatively, the results also interestingly suggest a pathway for us to close that achievement gap with struggling students in the lower grades with the PBL approach to teaching and learning, which would again prove to be effective with higher performing students in middle schools.

The results of the one-way between-subjects ANOVA test conducted to analyze the possible differences between schools at different implementation levels of PBL was also statistically significant. The ANOVA analysis showed that there was a significant difference in students' achievement on NYS ELA Test at the $p < .01$ level for the three conditions: the three PBL implementations levels. Post hoc comparisons using the Tukey HSD test indicated that the ELA mean score for the PBL Implementation Level 1 condition (No/Beginning PBL Implementation) was significantly different than the PBL Implementation Level 3 condition (*Full* School-wide PBL Implementation) at the $p = .000$ level. The ELA mean score for the PBL Implementation Level 1 condition was also significantly different than the PBL Implementation Level 2 condition (School-wide PBL Implementation) at the $p = .001$ level. Taken together, the results suggest that the PBL approach to teaching has a profound impact on students' ELA academic achievement, regardless of the stage of implementation, but that a more "full" school-wide implementation would further benefit students academically. This finding is an encouraging finding that could empower educators to reflect on our current practices and to make shifts to provide students with more PBL opportunities that may support students' academic achievement, especially for lower performing and high achieving

students. Implementing and sustaining a school-wide shift in practice is difficult work, but as Snyder and Snyder (2008), states, "Learning environment that actively engage students in the investigation of information and the application of knowledge will promote students' critical thinking skills…The effort is worth the reward: students who can critically think for themselves and solve real-world problems" (p. 97).

Comparison of math academic achievement by type of teaching approach.

The results of the Independent Samples T-test conducted to compare students' achievement on the 4th and 8th grade NYS Math Test between PBL schools that employed PBL approach and schools that employed traditional teaching approach was also statistically significant. The mean score on the NYS Math for PBL schools (n = 26) was much higher than traditional schools (n = 39), resulting in the p value = .001. Results aggregated by the four different levels of performance on the NYS Math showed that, again, there was a significant difference in the percentage of Level 1 and Level 2 students between PBL and traditional schools, with traditional schools have a much higher percentage of students at the lower levels of academic achievement. On the other hand, the largest difference was shown between the percentage of level 4 students in PBL schools versus traditional schools (p = .000), which indicated that PBL schools had a much higher percentage of students obtaining Math academic achievement above grade-level (similar to ELA). While results of the Independent Samples T-Test, aggregated by 4th and 8th grade, showed similarly significant results overall, the 4th grade results showed that p = .001, whereas, the 8th grade results showed p < .05. These results suggest that PBL approach to teaching has a large effect on students' academic achievement in mathematics as well. The results suggest that when schools employ PBL approach to

teaching, students' academic achievement in mathematics also increases significantly. The results of the one-way between-subjects ANOVA test conducted to analyze the possible differences between schools at different implementation levels of PBL was again statistically significant. The ANOVA analysis showed that there was a significant difference in students' achievement on the NYS Math Test for the three conditions: the three PBL implementations levels. The significant difference in students' achievement on the NYS Math Test showed $p = .000$, which was even more profound than that of the NYS ELA Test ($p < .01$). These results confirmed Han, Rosli, Capraro and Capraro's (2016) finding that "Students who demonstrate deep catalyzing understanding of integrated STEM develop profound understanding of the underlying content….the result is that with STEM PBL has a greater impact on student learning than did business as usual (no STEM PBL) group" (p. 12). .

Differences in the NYC School Survey between type of schools.

Social interaction is an integral part of learning. This understanding, in our global world today, is proving to be even more critical. Vygotsky's (1962) social constructivist theory posits that knowledge is co-constructed and that students learn from the interactions with the teacher and with one another. In another study, Rosenthal and Jacobsen (1968) posits that teachers' expectations in the classroom strongly influence students' academic and intellectual growth. Therefore, creating a cognitively challenging environment with high expectations established for students, yet safe and supportive for students to take intellectual risks, is crucial for students' academic success. Furthermore, a growing body of research shows that peer interactions in the classroom, such as student discussions, is as important as the student-teacher interactions. Tullis and Goldstone

(2020) states, “Learning through peer instruction may involve deep processing as peers actively challenge each other, and this deep processing may effectively support long term retention” (p. 10).

As shown in the literature review, the quality of student discussions in the classroom and the development of a supportive classroom environment is strongly connected to the way instruction is delivered. To compare the school and classroom learning environment between schools that employed PBL approach and schools that employed traditional teaching approach, ANOVA was conducted to test for significant differences in the subcategories of the NYC School Survey - Quality of Student Discussion & Supportive Environment with High Expectations, between schools that employed PBL approach to teaching and schools that employed traditional approach to teaching. The descriptive statistics for the ANOVA analysis indicated a higher mean score for both Quality of Student Discussions and Supportive Environment with High Expectations for PBL schools, when compared to traditional schools.

A one-way between-subjects ANOVA analysis conducted indicated that there was a significant difference in the Quality of Student Discussions scores between PBL schools and traditional schools at the $p < .01$ level for the condition. The results suggested that the correlation between the type of teaching approach employed by schools to the quality of student discussions promoted in the classroom is significant, which likely then impacts students’ academic achievement. This confirms Dewey’s (1933, 1938) experiential learning theory that posits that learning occurs within a social environment where knowledge is constructed through students’ active experiences. Furthermore, the ANOVA analysis showed that there was also a significant difference in

the Supportive Environment with High Expectations scores between PBL schools and traditional schools at the $p < .05$ level for the condition. The results confirm the assertion made by Rosenthal and Jacobsen (1968) that teachers' expectations of their students have a strong impact on students' academic outcomes. Again, the results imply that the strong correlation seen between the type of teaching approach employed by schools to the level of high expectations and supports in the classroom likely promote an optimal learning environment for students' academic success.

Predictors of students' academic achievement.

Wang, Zhou, and Chen (2013) claim that creativity involves the "ability to offer new perspectives, generate novel and meaningful ideas, raise new questions, and come up with solutions to ill-defined problems" and that creativity has been viewed as "the ultimate economic resource and as essential for addressing complex individual and societal issues" (p. 2202). They posit that project-based learning (PBL) encompasses two important elements that "can provide conditions of creativity development": solving authentic problems and group work (Wang et al., 2013, p. 2202). In other words, the PBL approach of teaching and learning can effectively nurture students' creativity and problem-solving skills, which is critical to our children's success in the 21st century.

To examine which variables, teaching approach (PBL vs. traditional), supportive environment of high expectations, and/or quality of student discussion, predict students' achievement in ELA and Mathematics significantly, a regression analysis was conducted. The results of the regression analysis indicated that the model explained 36.6% of the variance and that the model was a significant predictor of ELA achievement. Likewise, an additional multiple regression analysis was conducted to predict the NYS Math

achievement based on teaching method, supportive environment of high expectations, and the quality of student discussions. The results of the regression indicated that the model explained 42.6% of the variance and that the model was a significant predictor of Math achievement. Further analysis showed that the teaching approach and the quality of student discussions in the classroom were significant predictors of both ELA and Math achievement, but the supportive environment was not a significant predictor. This may be due to confounding factors within each classroom and schools that could not be accounted for, such as teachers' perception of the school outside of their classrooms, the condition of the environment when the survey was taken, the varying understanding of the survey test items, etc. Nevertheless, the findings imply that more innovative approaches to teaching and learning, such as project-based learning (PBL), may provide students with the opportunity to utilize their knowledge of the specific content area, as well as their creativity and problem-solving skills, to draw out new solutions within the confines of the context and/or environment. PBL may also impact the school and classroom learning environment positively, thereby producing an increase in students' academic achievement.

Relationship to Prior Research

PBL and its impact on the learning environment.

The significant findings in this study between PBL and Supportive Environment of High Expectations confirm DeWaters, Andersen, Calderwood, and Powers' (2014) study where they found that the opportunity for students to engage authentically with real-life issues and data, as well as the ability for students to engage in problem-solving

on their own, resulted in a high level of student engagement in critical thinking skills, which then increased student ownership over the content. An ANOVA analysis in this current study showed that PBL schools developed an environment of rigor and supports at significantly higher levels than traditional schools. This finding expanded the findings from the study conducted by DeWaters et al. (2014) by using standardized assessments as main instruments in the study, which provided more reliability than the self-assessment used by DeWaters et al.'s (2014) study. Hugerat (2016) also explored how the PBL approach to teaching science affects the classroom learning environment compared to traditional teaching and found that PBL approach supported an environment of rigor and high expectations for students. This current study expanded Hugerat's (2016) findings as well by using the NYC School Survey as an instrument, which includes questions regarding the culture of the classroom/school, compared to the survey used in Hugerat's (2016) study, which limited the questions to students' perception of the climate of the classroom. This study also broadened the inquiry to teachers' assessment of the learning environment of the school, which likely decreased the subjectivity and variability of the participants' responses.

Walters & Sirotiak (2011), who conducted a study assessing the effect of project-based learning on "soft skills", such as leadership abilities and communication skills, found that PBL approach to teaching encourages students to engage in the content and with one another meaningfully, likely leading to broader and more long-term learning outcomes, which include the development of softer skills, such as communication skills. The limitations of Walters & Sirotiak's (2011) research included the limited number of participants and school (n = 1) involved in the study. While this current study confirmed

the findings in Walters & Sirotiak's (2011) study to a large extent, it also expanded their research to a much larger number of schools (n = 72).

PBL and its impact on academic achievement.

This study found that there are statistically significant differences in students' achievement on the 4th and 8th grade NYS ELA and Mathematics Test between schools that employ project-based learning approach as the core method of instruction versus schools that employ a traditional approach to teaching and learning. The findings also revealed that there is a statistically significant difference in students' academic achievement between schools in different PBL implementation levels. These remarkable findings confirm the findings in the report, which described a three-year project study launched by Expeditionary Learning Outward Bound USA (ELOB) in 1992, where they found that nine out of ten Expeditionary Learning schools increased student achievement steadily over the years (Weinbaum et al., 1996, p. 23). One limitation of the ELOB study was that there was no common assessment used as an instrument for participating schools. This study not only confirms Weinbaum et al. (1996)'s arguments for adopting the PBL approach, but it also helps fill the gap in the study. Çevik's (2018) study, which explored the impact of Science, Technology, Engineering, and Mathematics (STEM)-based PBL education on the academic achievement of 11th grade students at a vocational high school, also found that students made statistically significant academic gains, as well as strengthen their career interests through PBL education. A limitation of Çevik's (2018) study was not having a control group to make comparisons with. This current study both confirmed and expanded the findings in Çevik's (2018) study.

The literature review, together with findings in this study, confirm the theoretical framework presented in chapter 1. PBL approach, as evidenced by the findings in this

study, helps create a learning environment with high expectations where students are expected to take ownership of their own learning. In addition, the PBL approach also helps create a learning environment, conducive to high quality student discussions, in which communication and collaboration skills take a central place in the learning process. The findings in this study suggest that the positive learning environment, promoted by the PBL approach serve to increase students' academic achievement in both ELA and in Math. These findings make a strong case for our education system to reexamine our current instructional practices to include deliberate effort in developing students' creativity, critical thinking, problem-solving, and communication skills critical for our children's success in the 21st century.

Connection between PBL and culturally relevant pedagogy.

The results of the regression analysis in this study showed that the PBL approach, as well as the quality of student discussions, were significant predictors of students' academic achievement on standardized exams. This result is an encouraging finding that can propel schools to step out of the decades-old practice of focusing on factual and procedural knowledge. Educators can no longer be satisfied with merely covering content material. Rather, we must go deeper in each content area by providing students with regular and more frequent opportunities for quality student discussions. Providing students with opportunities to engage with one another on more long-term collaborative projects will also increase opportunities for students to use their creativity and other assets to come up with new solutions. Joy & Kolb (2008) also found that "Culture has a significant effect in deciding a person's preference for abstract conceptualization versus concrete experience" (p. 83). Therefore, finding new, dynamic approaches to teaching,

such as PBL, that is more relevant to our children's world today and providing multiple pathways to reach students of color, who continue to combat multiple layers of disadvantages, is critical to closing the achievement gap that is so persistent in our society. Following Gloria Ladson-Billings's (1995, 2001) tenets of culturally relevant pedagogy, we need to acknowledge the presence of inequity, uphold high expectations for all our students, demonstrate cultural competence, and work to support our culturally diverse students with an asset-driven mindset and a student-centered learning environment.

Limitations of the Study

This study had a few limitations. First, while the sample size was large enough to make generalizations, it also broadened the potential for confounding variables that could not be accounted for in the study, which may have included the condition of the survey administration, the varying curricula across the schools, varying levels of administrative support, etc. Another limitation was the variability between superintendents across the two districts with regards to the level of emphasis he/she may have placed on PBL practices, as well as the variability in the level of the supports being provided to the schools in the district. Lastly, the fact that this study was strictly a quantitative study posed some limitations in obtaining a full picture. A mixed study with some qualitative aspects may have allowed for a deeper look into the minds of participants and provided a more comprehensive picture.

Recommendations for Future Research

This study was a quantitative study, analyzing the impact of the different approaches to teaching on standardized assessments within one year. A more longitudinal

study that follows the process of PBL implementation simultaneously with the results of the standardized exams would be recommended. A mixed study that delves deeper into participants' learning experiences would also provide new perspectives. As stated in Chapter 1, the hope for this study was not to be able to make a narrow case for project-based learning, but to make a larger case for our education system to reexamine our current instructional practices to include deliberate effort in developing students' creativity, critical thinking, problem-solving, and communication skills, critical for our children's success in the 21st century. Therefore, recommendations for future research also include research on other alternate approaches to teaching, such as problem-based learning, Talents Unlimited, etc.

Recommendations for Future Practice

As it was stated multiple times in this study, if our children are to be competitive in the global world today, we can no longer be satisfied with instructional practices that focus on factual and procedural knowledge. Just as we tend to fall back on rearing our children the way we were reared as a child, educators, too, fall back on teaching the way we were taught as a child. The fact of the matter is, however, that we are currently educating our children for a future world that does not yet exist. Moreover, the speed of change is increasing at an exponential speed. Therefore, we must stop to reassess what skills are truly important for our children to acquire, in order to be best prepared for their futures. We also have to continually reflect whether our current practice truly provides the educational opportunities that our children need to develop their creativity and problem-solving skills. In addition, finding alternative and multiple pathways to reach

students of color, who continue to face an exorbitant number of disadvantages, may be one of the many steps toward equity in education.

REFERENCES

Anderson, J. (2010). Interdisciplinary Project-Based Learning Leads to Success. *Tech Directions*, 70(4), 20–21.

Amabile, T. M. (1983). The social psychology of creativity: A componential conceptualization. *Journal of Personality and Social Psychology, 45*(2), 357-376

Ayaz, M. F., & Mikail Söylemez. (2015). The effect of the project-based learning approach on the academic achievements of the students in science classes in turkey: A meta-analysis study. *Egitim Ve Bilim, 40*(178) Retrieved from https://jerome.stjohns.edu/login?url=https://search-proquest-com.jerome.stjohns.edu/docview/2113644835?accountid=14068

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House*, 83(2), 39-43.

Boaler, J. (1998b). Open and closed mathematics: Student experiences and understanding. *Journal for Research in Mathematics Education*, 29(1), 41.

Buck Institute for Education. (2014). *What is project-based learning*? Retrieved from http://bie.org/about/what_pbl

Çevik, M. (2018). Impacts of the project based (PBL) science, technology, engineering and mathematics (STEM) education on academic achievement and career interests of vocational high school students. *Journal of Education and Instruction*, 8(2), 281-306.

Costa, A. L. (2008). The Thought-filled Curriculum. *Educational Leadership*, 65(5), 20-24.

Csikszentmihaly, M. (1989), Society, Culture, and person: Systems view of creativity. In R. Sternberg (Ed.), *The Nature of creativity: Contemporary psychological perspectives* (pp. 325-349), NY: Cambridge University Press.

DeWaters, J. E., Andersen, C., Calderwood, A., & Powers, S. E. (2014). Improving climate literacy with project-based modules rich in educational rigor and relevance. *Journal of Geoscience Education*, 62(3), 469-484.

Dewey, J. (1933). How We Think: A Restatement of the Relation of Reflective Thinking to the Educative Process. Boston, MA: D.C. Heath & Co Publishers.

Dewey, J. (1938/1963). Experience and Education. New York: Simon & Schuster

Gardner, H., & Moran, S. (2006). The science of multiple intelligences theory: A response to Lynn Waterhouse. *Educational Psychologist, 41*(4), 227-232.

Han, S., Rosli, R., Capraro, M. M., & Capraro, R. M. (2016). The effect of science, technology, engineering and mathematics (STEM) project based learning (PBL) on students' achievement in four mathematics topics. *Journal of Turkish Science Education*, 13(3)

Hugerat, M. (2016). How teaching science using project-based learning strategies affects the classroom learning environment. *Learning Environments Research*, 19(3), 383-395.

Jensen, K. J. (2015). A meta-analysis of the effects of problem- and project-based learning on academic achievement in grades 6-12 populations Available from Education Database. (1707108289). Retrieved from https://jerome.stjohns.edu/login?url=https://search-proquest-com.jerome.stjohns.edu/docview/1707108289?accountid=14068

Joy, Simy & Kolb, David. (2009). Learning Styles & Culture 1 Are There Cultural Differences in Learning Style?. *International Journal of Intercultural Relations.* 33. 69-85. 10.1016/j.ijintrel.2008.11.002.

Kolb, D.A. (1981). Learning styles and disciplinary differences, in: A.W. Chickering (Ed.) The Modern American College (pp. 232–255). San Francisco, LA: Jossey-Bass.

Ladson-Billings, G. J. (2006). From the achievement gap to the education debt: Understanding achievement in U. S. schools. *Educational Researcher, 35*(7), 3-12.

Ladson-Billings, G. J. (1998). Just what is critical race theory and what's it doing in a nice field like education? *International Journal of Qualitative Studies in Education, 11*(1), 7-24.

Leshkovska, E. A., & Spaseva, S. M. (2016). John Dewey's Educational Theory and Educational Implications of Howard Gardner's Multiple Intelligences Theory. *International Journal of Cognitive Research in Science, Engineering and Education, 4*(2), 57-66.

Mansilla, V.B. & Gardner, H. (2008). Disciplining the mind. *Educational Leadership*, 65(5).

Omdal, S. N. & Graefe, A. K. (2017). Investing in creativity in students: The long and short (term) of it. In J. A. Plucker (Ed.). *Creativity and innovation: Theory, research, and practice* (pp. 205-222), Waco, TX: Prufrock Press Inc.

Perkins, D. (2011). Knowledge Alive. In Ornstein, *Contemporary Issues in Curriculum* (Vol. 5th Edition, pp. 242-247). Boston, MA, US: Pearson.

Qian, M. & Plucker, J. A. (2017). Creativity assessment. In J. A. Plucker (Ed.). Creativity and innovation: Theory, research, and practice (pp.223-234), Waco, TX: Prufrock Press Inc.

Reis, S. M. & Renzulli, J. S. (2001) The schoolwide enrichment model: Developing students' creativity and talents. In M. D. Lynch & C. R. Harris (Eds.). Fostering creativity in children, K-8: Theory and practice (pp.14-54). Needham Heights, MA: Allyn & Bacon

Romanelli, F., Bird, E., & Ryan, M. (2009). Learning styles: a review of theory, application, and best practices. *American journal of pharmaceutical education*, *73*(1), 9. https://doi.org/10.5688/aj730109

Rosenthal, R., & Jacobson, L. (1968). Pygmalion in the classroom. *The Urban Review*, 3(1), 16–20. doi:10.1007/BF02322211

Rosenthal, R., Jacobson, L. (2003). Pygmalion in the classroom: teacher expectation and pupil's intellectual development. United Kingdom: Crown House.

Schwartz, D. L. (1995). The emergence of abstract representations in dyad problem solving. *The Journal of the Learning Sciences*, 4, 321–354.

Shafaei, A., Poorverdi, M., & Parvizi, B. (2007). Use of project-based learning in increasing students' vocabulary knowledge & communicative ability.

Smith, J. (2002). Learning styles: Fashion fad or lever for change? the application of learning style theory to inclusive curriculum delivery: Journal of the association for programmed learning ETTI. *Innovations in Education and Teaching International, 39*(1), 63-70.

Snyder, L. G., & Snyder, M. J. (2008). Teaching critical thinking and problem solving skills. *Delta Pi Epsilon Journal*, 50(2), 90-99.

Sousa, D. A. (2002). *How the Gifted Brain Learns*. Corwin Press.

Summers, E. J., & Dickinson, G. (2012). A Longitudinal Investigation of Project–based Instruction and Student Achievement in High School Social Studies. *Interdisciplinary Journal of Problem-Based Learning*, 6(1), 6.

Thomas, J. W. (2000). *A Review of Research on Project-based Learning* (p. 49). San Reafael, CA.

Tullis, J. G., & Goldstone, R. L. (2020). Why does peer instruction benefit student learning?: Principles and implications. *Cognitive Research, 5*(1) doi:http://dx.doi.org.jerome.stjohns.edu:81/10.1186/s41235-020-00218-5

Wang, F., Zhou, C. F., & Chen, H. B. (2013). Introducing project-based learning to design enterprises for creativity. Applied Mechanics and Materials, 423-426, 2202.

Walters, R. C., & Sirotiak, T. (2011, April). Assessing the effect of project based learning on leadership abilities and communication skills. In 47th ASC Annual International Conference Proceedings.

Wirkala, C., & Kuhn, D.. (2011). Problem-Based Learning in K-12 Education: Is it Effective and How Does it Achieve its Effects?. *American Educational Research Journal*, *48*(5), 1157–1186.

Voronchenko, T., Klimenko, T., & Kostina, I. (2015). Learning to live in a global world: project-based learning in multicultural student groups as a pedagogy of tolerance

strategy. *Procedia - Social and Behavioral Sciences*, *191*, 1489–1495. https://doi.org/10.1016/j.sbspro.2015.04.472

Vygotsky, L. S. (1962). *Thought and language*. Cambridge MA: MIT Press.

Vygotsky, L. (1978). *Interaction between learning and development.* Readings on the development of children, 23(3), 34-41.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Zedan, R. (2008). Classroom climate among pupils of Arab elementary schools in Israel. *Iyunim be-Nihul ve-Irgun ha-Hinukh*, 30, 51–80. (In Hebrew).

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