University of New Mexico
UNM Digital Repository

Special Education ETDs | Education ETDs

Summer 7-9-2020

Project-Based Learning Instruction for a Student with Disabilities: Experiences of a Student and Teachers

Robert C. Shauger
University of New Mexico

Follow this and additional works at: https://digitalrepository.unm.edu/educ_spcd_etds

 Part of the Secondary Education Commons, and the Special Education and Teaching Commons

Recommended Citation

Shauger, Robert C.. "Project-Based Learning Instruction for a Student with Disabilities: Experiences of a Student and Teachers." (2020). https://digitalrepository.unm.edu/educ_spcd_etds/43

This Dissertation is brought to you for free and open access by the Education ETDs at UNM Digital Repository. It has been accepted for inclusion in Special Education ETDs by an authorized administrator of UNM Digital Repository. For more information, please contact amywinter@unm.edu, lsloane@salud.unm.edu, sarahrk@unm.edu.

Robert C. Shauger
Candidate

Special Education
Department

This dissertation is approved, and it is acceptable in quality and form for publication:

Approved by the Dissertation Committee:

Susan Copeland, Ph.D., Chairperson

Ruth Luckasson, J.D.

Julia Scherba de Valenzuela, Ph.D.

Vanessa Svihla, Ph.D.

PROJECT-BASED LEARNING INSTRUCTION FOR A STUDENT WITH DISABILITIES: EXPERIENCES OF A STUDENT AND TEACHERS

BY

ROBERT C. SHAUGER

B.S., Biology, Portland State University, 1997
M.A., Curriculum and Instruction, University of New Mexico, 2001

DISSERTATION

Submitted in Partial Fulfillment of the
Requirements for the Degree of
Doctor of Philosophy

Special Education

The University of New Mexico
Albuquerque, New Mexico

July, 2020

©2020, Robert C. Shauger

DEDICATION

I would like to dedicate this dissertation to the many people each year who strive to make it through high school. The youth and young adults that have shaped my thinking and practice over the last 20 years have driven my passion for opportunity and access for all learners. Without the people who have made it (and did not) I would not be here today.

ACKNOWLEDGEMENTS

First, I would like to acknowledge my advisor, Dr. Susan Copeland for being the advisor I have needed all along. Her ability to nurture, support, push, and challenge me at various times through this process is the reason I am here today. I would also like to thank Dr. Julia Scherba De Valenzuela, who has always given me the reality of this process and supported me with guidance on theory as well as being a whiz with audio equipment.

Dr. Vanessa Svihla has been a significant support from the beginning of this process as well. Her commitment to educational reform in the local and national setting has helped me understand that my study is important and worth sharing because innovation in education is not easy. Dr. Svihla has been there through the high points and low points of my journey and knows how to encourage me through stumbles and grace.

I would like to thank the entire department of Special Education and specifically Prof. Ruth Luckasson, who have all created a sense of purpose and justice for people with disabilities. My journey through this process has emboldened my commitment to justice for people with disabilities who have been marginalized in public education as well as society as a whole. A huge thank you to the members of my doctoral student group: Sharon Lee Head Deborah Huggins, Peggy Duffie, Heather Di Luzio, Jordan Morales, and Ashley Collins have all served as support, critical friends, and professional colleagues for me through this process.

Finally, I would like to thank my personal support network. The people who have made my journey bearable and kept me from throwing my computer off of the edge of the Grand Canyon. To my wife Tori: your support personally and professionally through this long process has gotten us here. Thank you. For my daughter Aspen, who has watched my journey to becoming a scholar emerge as you have started your own journey, I hope your path takes you to amazing places where you never thought you would go. Mine has. To my dad, who checked in with me at just the right times to talk me back into writing, and who has always been a compassionate supporter of mine. Lastly, to friends who have made this last part of the journey happen: Angela Jennings and Keven MacRunnels, your friendship has meant the world to me for many years and your support in moments of crisis have made this dissertation possible. Thank you all!

PROJECT-BASED LEARNING INSTRUCTION FOR A STUDENT WITH DISABILITIES: EXPERIENCES OF A STUDENT AND TEACHERS

by

Robert C. Shauger

B.S., Biology, Portland State University, 1997
M.A., Curriculum and Instruction, University of New Mexico, 2001
Ph.D., Special Education, University of New Mexico, 2020

ABSTRACT

Students with disabilities have been underrepresented in research examining the implementation of project-based learning (PBL) instruction. This qualitative case study described the experiences of a student with a disability in an inclusive classroom where teachers used PBL instruction. I used interviews, observations, audio recorded conversations in class, and analyzed teacher-created curriculum documents and student artifacts. Thematic analysis generated four primary themes including: Supporting students, student buy-in, teacher and student interactions in PBL are complex, and student demonstration of learning. Recommendations for classroom practice to support students with disabilities in PBL instruction included extensive teacher collaboration, individualized instruction, and teaching students time management skills. Extensive and continuous regular planning time and an emphasis on the social nature of learning also emerged as important implications for teacher practice. Suggestions for future research include more studies investigating PBL instruction including students with disabilities as well as studies of PBL in other settings.

Keywords: disability, project-based learning, inclusion, descriptive research, case study

TABLE OF CONTENTS

LIST OF TABLES

Chapter One

Introduction

The Buck Institute for Education has defined Project-Based Learning (PBL) instruction as a method of guiding a student "through the curriculum by a meaningful question to explore an engaging real-world problem to solve, or a design challenge to meet" (Larmer et al., 2009, p. 4). Learners are tasked with solving real problems "in situations where they use cognitive strategies, tools, and other individuals as resources" (Krajcik et al., 1994, p. 488). Further, these authors also stated that the PBL instructional problems that focus students' learning have the following criteria: they are (a) feasible, (b) worthwhile, (c) contextualized, and (d) meaningful. The feasibility of the question posed by the problem is measured by its ability to be answered by the students. The worthiness of the question is related to its academic content and the ability for students to break it down into smaller components. The contextualization of the question is judged on its connection to real world and important topics, and finally, the question's meaningfulness is connected to how important it is to the students in their own worlds. Taking all of this into consideration, PBL instruction is not simply an activity that is related to the topics of a lesson, it is a whole teaching system that should be implemented across all experiences that students have in a classroom to connect and contextualize their learning. For example, simply dressing in a toga and cooking the food of ancient Romans would not help students in their understanding of the political systems of democracy. Instead, to offer students a more meaningful experience the teacher might have students reenact a debate on Caesar's request for more troops and at the end have a panel discussion of how senate actions like these compare to the current political process in the

United States for an increase in defense spending and troop deployment.

The National Longitudinal Transition Study (National Center for Special Education Research [NCSER], 2011) found that people with disabilities had significant differences in employment outcomes in their lives when compared to their adult peers and that people with disabilities who enrolled in post-secondary education institutions graduated at a lower rate than their peers. In the realm of employment, individuals with disabilities earned less money hourly on average than their typical peers. Since students with disabilities have experienced underemployment and unemployment at higher rates than their typically developing peers, as a teacher, I strive to help students develop not only academic skills but help them deliberately transfer what they have learned into realms beyond the classroom to change these poor outcomes. By doing this I hope to show students with disabilities that what they are learning is meaningful and can help them beyond the school classroom. This motivation is why I chose to work at a school that based its entire curriculum in PBL instruction.

Although PBL instruction has been the focus of studies in several disciplines and levels of schooling that extend from terminal professional degrees to the earliest years in education across many different types of settings, students with disabilities have been underrepresented in the PBL instruction literature. PBL classrooms might be effective instructional settings for students with disabilities but little research has been conducted to determine if this is so. The lack of research describing outcomes for students with disabilities in classrooms using PBL instruction or how instruction in those classrooms has een adjusted for their individual learning needs is concerning because over 2 million learners in the U.S. have been identified with disabilities (e.g., Specific Learning

Disability; SLD).

Learners with SLD might have difficulties engaging in the general education classroom. The difficulties that a learner with SLD experiences may be generalized to include learning challenges that may "affect the acquisition, organization, retention, understanding or use of verbal or nonverbal information" (Learning Disabilities Association of America (LDAA), 2018. Para. 1). Learning disabilities trace their genesis to impairments in processes related to perceiving, thinking, remembering or learning. Based on the description of learning disabilities from the LDAA students with SLD might have difficulties (a) listening, speaking, and understanding oral language; (b) decoding, phonetic knowledge, word recognition, and comprehension while reading; (c) spelling, written expression, and writing fluency in written language; (d) and computation, problem-solving, number sense, and math fact fluency, spatial sense and verbal mediation of concepts in math. (para. 2). Students who experience learning difficulties in the areas of oral language, reading, written language, and math might experience unique challenges in classrooms that incorporate PBL instruction. For example, a student conducting research to better understand a problem in PBL instruction might struggle with gaining content knowledge and skills independently and require specialized instruction in order to acquire skills and knowledge that they need to learn. Conversely, the unique features of PBL instruction might offer ways to facilitate learning of students with SLD who may do better in classrooms in which there are hands-on, concrete ways to engage with learning materials and multiple options to demonstrate learning.

Unfortunately, even with the findings of studies showing promise of positive

outcomes associated with PBL instruction, a clear connection between increased academic knowledge acquisition for students with disabilities and PBL instructional methods had not been thoroughly documented. The evidence for PBL instruction's efficacy for students with disabilities has not yet been firmly established, and the small number of studies that have included students with disabilities has found both positive and negative outcomes.

Positive Findings Associated with PBL Instruction

Some examples of positive findings related to PBL instruction relate to both academic gains and student satisfaction. PBL instruction has been found to positively impact standardized test scores of urban minority science students in middle school (Geier et al., 2008) and also showed promise for narrowing the achievement gap in schools with second grade students who come from low socio-economic backgrounds (Halvorsen et al., 2012).

Two studies in particular showed that students enjoy PBL instruction, and also that its positive effects on academic knowledge are associated with long-term implementation (e.g., eight weeks; three years). Filippatou and Kaldi (2010) found positive student outcomes during PBL instruction across 8 weeks on student attitude towards learning, based on responses from interviews and attitudes scale surveys (Filippatou & Kaldi, 2010). The authors noted that students with disabilities described that they enjoyed group work with their peers, and that they rated their self-efficacy in content knowledge as higher during PBL instruction; liked working in teams more than working individually; and thought that PBL instruction was better than traditional instruction. Summers and Dickinson (2012) conducted a three-year longitudinal study in

an entire high school that chose to implement PBL instruction. The researchers used state standard assessment data from the participants and compared it to the same data from its sister school in the community that did not use PBL instruction. Findings indicated that students receiving special education services in the PBL instruction school demonstrated greater social studies knowledge compared to their peers in the traditional high school control group in their tenth and eleventh grade years but not in their ninth-grade years. The authors connected this finding to earlier research that demonstrated that PBL instruction was effective for long-term retention and performance improvement. The authors noted from interview data that the freshman students in the school that used PBL instruction were unsatisfied with the peer monitoring and accountability in the classes.

The findings from Summers and Dickinson (2012) suggested that students with disabilities in this study needed extended time in a classroom using PBL instruction to benefit both academically and socially from the teaching method. However, even when the students in the study were struggling with collaboration in the group aspects of the projects, they still preferred PBL instruction to other forms of teaching.

Negative Findings Associated with PBL Instruction

PBL instruction has also been shown in some studies to negatively impact some aspects of learning of students with disabilities. For example, five students with disabilities in Filippatou and Kaldi's (2010) study reported that they took a passive role in their group's learning activities. Later research (Carman & Chapparo, 2012) found that students with disabilities might have difficulties engaging in group work because they lack adequate social skills. These findings suggest a need in classrooms that use PBL instruction to help students understand how to effectively collaborate with group

members and find the work that they personally can contribute to the project.

Proponents of PBL instruction have responded to criticisms in the literature by arguing that project-based instruction has the ability to enhance students' motivation and thinking process in the classroom (Blumenfeld et al., 1991). Given the limited research to date examining the use of PBL instruction with students with disabilities and the mixed findings of the existing research, there is a need to further explore the experience of students with disabilities in this instructional strategy to determine if and how this teaching approach is of benefit to these learners. I designed my study to consider the main criticisms of PBL (i.e., that this approach is associated with limited student engagement in collaborative project work, mixed positive academic outcomes, and limited or ineffective interactions with peer work groups) and to address a gap in the research (i.e., the limited number of studies involving students who have an identified disability).

Theoretical Framework Undergirding PBL Instruction

PBL instruction is rooted in constructivist and constructionist ideals. Papert described *constructionism* as having roots in constructivism, but extending the theory (Kafai & Resnick, 1996). Papert's work focused on "how a culture, a way of thinking, an idea comes to inhabit a young mind" (Papert, 1993, p. 10). Papert took the idea of the "child as builder" of knowledge as a foundation for his ideas on how children learn. When Papert described his own thinking about learning, he connected deeply to Piaget's concept of schema. "What an individual can learn, and how he learns it depends on what models he has available" (p. xix). The child, when learning, can pick up concepts "early and spontaneously" when the culture of the child is rich in examples of the concepts and

"materials that would make the learning much more simple and concrete" (Papert, 1993, p. 7). This idea was very similar to the thinking of Piaget about schema.

Piaget's concept of *schema* is at the heart of *constructivist* (see Peterson, 2012; von Glasersfeld, 1989) and arguably, *constructionist* theory. According to Piaget, knowledge is constructed through learners trying to synch new information with models of what they already know and understand. A schema is a cognitive understanding of an idea or concept built through phenomena. New experiences either are *assimilated* into the existing knowledge of a concept or *accommodated* to fit the new experiences into the learner's previous models of understanding (Carpendale et al., 2008). Assimilation involves the new knowledge fitting into and adding detail to the existing knowledge without changing the major understandings of the model. Accommodation happens when the new learning is in conflict with the major understandings of the model of understanding and the model is changed. *Equilibrium* in the schema is reached when new information is either assimilated into the model or the schema of the model is accommodated based on the new experiences. Modern constructivism is based on Piaget's ideas and involves basic assumptions about learning. Harris and Graham (1994) summarized these assumptions as the learner actively constructing knowledge using previous knowledge and experiences as the starting point for new learning.

The basic tenets of constructivism are present in the *constructionist* theory of education; it is just that the construction of knowledge is anchored specifically in making something as part of the students' learning. Constructivism's roots are also evident in Vico's conceptualization of knowledge (von Glasersfeld, 1989). The most important contribution that connects Vico to *constructionism* and PBL is the concept of "verum

ipsum factum" (the truth is the same as the made; von Glasersfeld, 1984). Knowing through building developed the foundations of PBL because learners, through the creation of products that represent their learning, construct knowledge. *Constructivists* have argued that knowledge building takes place in the mind with the learner developing models of understanding that help them navigate new experiences and connect them to their prior learning. *Constructionism* went further to argue that "learners are particularly likely to make new ideas when they are actively engaged in making some kind of external artifact" and "which they can reflect upon and share with others" (Kafai & Resnick, 1996, p.1).

Kafai and Resnick's (1996) description of Papert's *Constructionism* also connected to Vygotsky's ideas about how tools and symbols relate to each other in the developing child. The authors described tools as both physical tools (e.g., a hammer) and language tools (symbolic representations of actions). To clarify, the language tools (e.g., written language instructions), such as those found on a typical worksheet, that connect to curriculum were just as important for the child to learn how to use as a physical tool. Vygotsky and Luria (1994) argued that both language tools and physical tools are important for the child to navigate using language. Vygotsky and Luria studied how children used language in the development of *practical knowledge.* Practical knowledge in this case was characterized as a child learning how to use a physical or language tool. When a child is learning how to use a tool or technology beyond their own body, it is an experience anchored in the social environment of the learner and greatly dependent on interactions with others (Vygotsky & Luria, 1994). Further, the authors noted that when a child sees a difficulty in solving a problem and they cannot solve the difficulty

themselves, they ask for help.

In my study I used Vygotsky and Luria (1994) as the foundation of my interests in the social environment of PBL instruction. Interaction around tool use (e.g., a language tool and a physical tool) is important to my current study because the social interaction around the tool used in the context of PBL instruction created what Vygotsky and Luria describe as *higher psychological function*. The development of higher psychological function is promoted when the learner experiences what the authors called "two-fold stimulation" (p. 159). Two-fold stimulation happens when a student encounters a simple stimulation (e.g., a physical response of learning such as learning through doing physical work) and a second stimulation that the authors described as an auxiliary means of behavior (i.e., interactions between people while using a tool). The authors argued that when children experience two-fold stimulation around tool use they combine practical activity with symbolic activity to create more meaningful and higher-level learning than either done separately.

In the early twentieth century American educators were seeing the need for education to be connected to solving real life problems and ideas. Kilpatrick wrote "We of America have for years increasingly desired that education be considered as life itself and not as a mere preparation for later living" (1929, p. 6). *Constructionism* traced its origins back to Dewey and Kilpatrick. Based on the theoretical foundation of constructivism, Kilpatrick, a student and successor to John Dewey, introduced the "project method" in 1929. Both Kilpatrick and Dewey argued for purpose in education through meaningful experiences that connected to students' lives. Kilpatrick described the act of a student making a dress. If the student planned and made the dress that is

merely a project. If it is done in a social context, making a dress for her to wear in a social setting, or a student writing a newspaper article to be published in the school newspaper to be viewed by others, then these are examples of purposeful acts. The key component beyond the completion of a project that makes an educational experience or "act" purposeful, is the social context beyond the teacher's evaluation and the walls of the classroom.

Kilpatrick's ideas of *purposeful acts* also connected to Vygotsky and Luria's (1994) thinking on the development of tool use. Vygotsky and Luria described purposeful activity as a connection between word and action. The authors argued that that the action of using a tool is linked to language and that without language, the development of knowledge about tool use mimics that of other primates, like chimpanzees, without a connection to cognition and purpose. Purposeful activity promotes two-fold stimulation as described earlier and thus promotes Vygotsky and Luria's (1994) concept of *higher psychological function* in the learner.

Constructionism also places an emphasis on meaningful experiences; its current form connected to Kilpatrick's (1929) ideas that the project work needs to be personally meaningful. In Kilpatrick's example of a student making a dress described above, if the student made the dress to be worn in a public setting after the work is complete, then this qualifies as a purposeful act and a project. The dress itself was something that had meaning to the learner and had personal value beyond what was expected in the context of the schoolroom. The student wore the dress after the project is complete and can then apply this learning to future work that will impact life beyond the classroom, namely, making more dresses.

Overview of Project-Based Learning Instruction

The conceptualization of PBL instruction that is used in the school that I chose to study has seven essential components (Larmer & Mergendoller, 2010). These include: (a) establishing a need to know with students; (b) creating a driving question with students; (c) allowing for student "voice and choice" in products; (d) incorporating 21st century skills (e.g., collaboration) in the curriculum; (e) allowing for inquiry and innovation in the curriculum; (f) giving students feedback and revision to improve their products; and (g) presenting products to a public audience. These PBL instructional components trace their origins back to Kilpatrick's (1929) ideas that purposeful acts in education that should connect to students' own experiences. The purposeful acts as outlined by Kilpatrick are connected to constructivist practice in education. All of the components mentioned above need to be present in a classroom that uses PBL instruction as the primary pedagogy. This means that when a student is engaged in PBL instruction in the classroom, they are doing work that is not only meant to build curricular knowledge, but the work is also meaningful in a larger context beyond the classroom. For example, reading a book and being assessed on its content in traditional pen and paper tests itself is not a purposeful act; however, if a student took an idea from the book and created and developed something from that idea that connected to his or her own life through making or doing something that is valuable to others beyond the teacher's grade book, then the student did what Kilpatrick imagined.

Both Larmer and Mergendoller (2010) and Harris and Graham's (1994) ideas of what constitutes PBL instruction draw from Kilpatrick's (1929) central principle that students' lives shape their understandings and their path to learning new concepts.

Considering the literature on PBL instruction, constructivism, constructionism, and purposeful acts, it appears that students' lives play a pivotal role in the learning of new concepts. In classrooms where teachers use PBL instruction this means that the students are actively engaged in personally meaningful experiences that promote acquisition of new academic knowledge.

Dewey (1933) further characterized authentic project learning as students having the ability to develop not only scientific knowledge but also "methods of scientific inquiry and proof" (p. 169). While this might seem only connected to topics in science, scientific inquiry, in Dewey's mind extended beyond the science classroom. According to Dewey, the learner developed proof of his or her own knowledge through scientific inquiry. "Not until a thing has been tried -or "tried out" in colloquial language- do we know its true worth" (p. 40). Students need to develop their own understandings of what is important to know and what is important to experience when they are experiencing learning in the classroom. This is much more about the inquiry and proof of a student's knowledge than a solely scientific pursuit.

Dewey also was concerned with students developing playfulness in addition to their ability to work. Playfulness to Dewy was about how students can find enjoyment and purpose in what they are learning. Work was about how a task proceeds to an end. Dewey argued that both needed to be present in the learning experiences of a student, the intrinsic interest in the experience itself, and the understanding of the perceived end, or point of the activity.

Dewey's (1933) ideas about acquiring knowledge went beyond content knowledge to procedural knowledge that promotes the ability to go beyond only

connecting learning to other learning. In his view, students should have been able to connect and apply new ideas and concepts in novel situations. In a classroom where teachers use PBL instruction, this would not just have looked like the students engaging in a lab and creating a lab report. The students would have to use the scientific knowledge that they built to create or build something that connected to their lives and the world outside of the school. For example, in the "Set in Stone" project at Henry High School (HHS), students were required to test different mixtures of concrete with lightweight aggregates. In a typical classroom this endeavor would end in a technical report. In the "Set in Stone" classroom the students proceeded to use these mixtures of lightweight cement to prototype and then create a full-sized canoe made of concrete. This last step illustrated what Dewey conceptualized as the expansion of learning beyond a classroom to a meaningful real-world context.

PBL instruction also emphasizes the importance of the learner's prior knowledge as a foundation to developing learning experiences. Although this connects to the Piagetian concept of schema as discussed earlier, where PBL instruction diverged from Piaget and connects more to Papert, Kilpatrick, and Dewey is in the use of tangible products as the vehicle and the representation of learning. As discussed earlier, Papert (1993) developed a new ideal for constructivism. Papert's ideal involved students exploring logic through the use of computer programming as a means to develop understandings of mathematical concepts. Eventually, he named this new constructivism as "constructionism" (Papert & Harel, 1991). *Constructionism* emphasized the construction of knowledge as being based in production of products that facilitated learning. According to Papert, when children learned the basics of computer

programming, they were learning the basis of logic, and logic informed how math was done. Before Papert, constructivism was much more based in the cognitive realm. Papert took Piaget's cognitive constructivism and anchored cognitive learning to concrete examples of knowledge in culture. Papert (1993) described children as "builders of their own cognitive structures" (p. 7) much like Piaget would have described. Papert noted that he diverged from Piaget in how the culture of the learner can offer materials for the child to build knowledge. He argued that the reason that slower development of knowledge for some learning can be attributed to "the relative poverty of the culture in those materials that would make the concept simple and concrete" (p. 7). Students forming new knowledge from their experiences was the central idea of constructivism. In constructionism "forming new relationships between knowledge is just as important as forming new representations of knowledge" (Kafai & Resnick, 1996, p. 2) and those relationships depend on the concrete and simple materials of the learner's culture that promote knowledge acquisition.

Vygotsky (1994a) related the importance of the environment to learning in children. Of particular interest to constructionism is his idea that "in child development that which is possible to achieve at the end and as the result of the developmental process, is already available in the environment" (p. 347). Since Papert anchored learning in the cultural materials of the child and Vygotsky also rooted learning in all which can be known by the learner in the environment, constructionism is a mixture of these theories and represents a wholly unique combination of the ideas of Dewey, Kilpatrick, Piaget, and Vygotsky.

Papert's ideas of constructionism thus created the foundations of PBL instruction.

Students engage in meaningful inquiry that is based in actual project products that connect to their own lives or their community while learning academic skills that help them connect future learning to the context of the knowledge.

Project-Based Learning Instruction: The Seven Components

Schools that use PBL instruction shape their curriculum using the seven components of modern PBL instruction as described earlier (Larmer & Mergendoller, 2010). These are: (a) establishing a need to know with students; (b) creating a driving question with students; (c) allowing for student voice and choice in products; (d) incorporating 21st century skills (e.g., collaboration) in the curriculum; (e) allowing for "inquiry and innovation" in the curriculum; (f) giving students feedback and revision to improve their products; and (g) presenting products to a public audience. In the following section I have defined and describe each component and how each has been integral to PBL.

Need to Know

Engaging students in the learning process is crucial. In PBL instruction, teachers facilitate engagement when they have created a need to know. The teacher- and student-developed need to know is a technique to help shape what the group should learn in order to solve the problem or create the project product and why they needed to learn it. The need to know in PBL instruction connects directly back to what Dewey and Kilpatrick said about students needing meaning in what they are learning and why they are learning it. Since teachers establishing a context for student learning has been shown to be effective in producing positive learning outcomes for students with disabilities (e.g., Lee & Songer, 2003; Stone et al., 2008), this component should be an essential part of any

PBL instruction with students with disabilities. A recent report by the Bill and Melinda Gates Foundation found that students surveyed cited the number one reason they reported that they dropped out of high school was that their classes were not interesting and did not connect to their lives (Bridgeland et al., 2006). The ability of students to construct the need to know with their teachers not only keeps students in school, it promotes collaboration between teachers and students and should help students engage in content learning embedded in the lessons.

Driving Question

The curriculum implemented by teachers in PBL instruction is focused around a driving question that gives a framework for the day-to-day learning in the classroom. Larmer and Mergendoller (2010) defined a driving question as a "proactive, open-ended, complex" question "linked to the core of what you want students to learn" (p. 36). PBL instruction not only gives the students a large conceptual question to anchor their learning, but it also supports teachers in developing learning experiences with students in order to produce the knowledge that they need to solve the problem (i.e., answer the question). Once again, the connection to real world learning is essential in PBL instruction not only because the foundational literature promotes the practice, but also because students' learning is enhanced when they develop a sense of *why* they are doing what they are doing in a class. Connecting real world problems to content knowledge in core content areas might benefit students by giving them a reason (i.e., need to know) to learn what they need to learn in school. The driving question provides the structure that helps students assimilate what they are learning into a meaningful whole.

Student Voice and Choice

Larmer and Mergendoller (2010) used student voice and choice to explain how students choose how they learn and how they demonstrate their learning in PBL instruction. The authors described this as a key component to make projects feel meaningful to students; they also stated that teachers should design projects to include student choice that fits their own teaching style and what will fit with the leaning needs and preferences of the students they are teaching. This can range from students choosing what topic they study, having a menu of choices for products of their learning, or students creating their own projects from the driving question, and selecting the resources they will use and the products they will create. As stated above, PBL instruction is rooted in constructionism. In particular, the component of PBL instruction that emphasizes voice and choice of students' learning fits well with constructionist thinking. Kafai and Resnick (1996) described constructionist learning environments in the introduction to their 1996 book as encouraging "multiple representations of knowledge" (p. 3).

Kafai and Resnick's (1996) brief description of constructionist learning environments also supports inclusive education practices such as differentiation. Much like Larmer and Mergendoller (2010), Tomlinson (1999) has described deliberate instructional planning to engage students based on their interests and academic needs. She called this instructional strategy differentiation (Tomlinson, 1999). Tomlinson et al. (2003) provided multiple examples of how differentiation promoted positive academic outcomes for all students. The authors defined differentiation as an "approach to teaching in which teachers proactively modify curricula, teaching methods, resources, learning activities, and student products to address the diverse needs of individual students" and "maximize the learning opportunity for each student" (p. 121). Since teachers using PBL

instruction have students address complex ideas and create project products that can demonstrate multiple skills and concepts, differentiation, or as Larmer and Mergendoller call it, voice and choice, of the process, content, and products of learning is not only possible but also essential for student success in PBL instruction.

Twenty-First Century Skills

Incorporating twenty-first century skills, including creativity and innovation, critical thinking and problem solving, and communication and collaboration (Partnership for 21st Century Learning, 2008) have allowed students learning through PBL instruction to engage in processes that connect with constructivist principles of knowledge discussed by Harris and Graham (1994). Students learning through PBL instruction construct their own knowledge through collaboration with peers and teachers. Collaboration as a tool for learning has been shown to have positive academic outcomes for students with disabilities (Gillies & Ashman, 2000) as well as facilitate their problem solving (Agran et al., 2001). Over 26 years ago, the U.S. Department of Labor said that schools needed to create meaningful experiences that prepare students for the workforce (U.S. Department of Labor, 1991). Authors of the report emphasized five competencies needed for students to be ready for the workplace of the 21st century. Students need to develop their abilities to (a) identify, organize, plan and allocate resources; (b) work well with others; (c) acquire and use information; (d) understand complex inter-relationships; and (e) work with a variety of technologies. These recommendations appear to be addressed by the fundamental components of PBL instruction outlined in this chapter.

Under the "Implications for Learning" of the report the Department of Labor (1991) also made three recommendations for how learning should happen in schools so it

will promote students' contextualizing their learning:

- Students do not need to learn basic skills before they learn problem-solving skills. The two go together. They are not sequential but mutually reinforcing.
- Learning should be reoriented away from mere mastery of information and toward encouraging students to recognize and solve problems.
- Real know-how (foundation and competencies) cannot be taught in isolation; students need practice in the application of these skills (p. 16).

All three of these recommendations could be addressed through the meaningful experiences Kilpatrick (1929) mentioned. Further, connecting curricula to real world thinking that was suggested to reduce dropout rates from the report by the Bill and Melinda Gates Foundation (Bridgeland et al., 2006) could also positively impact student engagement and retention. Students with and without disabilities can use the skills outlined by the U.S. Department of Labor (1991) as well as other 21st century skills as outlined by the Partnership for 21st Century Learning (2008) in order to succeed in PBL classrooms and ultimately their adult lives.

Inquiry and Innovation

Larmer and Mergendoller (2010) emphasized inquiry in PBL instruction as a curricular framework used to create new learning. Inquiry learning involves having students develop their own questions and investigate them through scientific and academic studies that are developed in collaboration with a teacher. The authors suggested that, "Students find project work more meaningful if they conduct real inquiry" (p. 36). This starts with the students' own questions, search for resources with the discovery of answers, generating new questions, testing ideas, and drawing their own

conclusions. This method of teaching has promise for students with disabilities. Students with disabilities who engage in inquiry learning like this have demonstrated favorable academic outcomes as measured by post-assessments of content knowledge for students with disabilities (Mastropieri & Scruggs, 1992; Mastropieri et al., 1999; Scruggs, 1993).

Feedback and Revision

Larmer and Mergendoller (2010) also suggested "formalizing a process for feedback and revision during a project makes learning meaningful because it emphasizes that creating high-quality products and performances is an important purpose of the endeavor" (p. 37). The authors further suggested that the teacher should use rubrics and other assessment criteria to coach students to develop their peer-feedback skills and to help students understand what is expected of them in project work. The practice of coaching students in how to give and receive feedback and in academic expectations has been shown to produce positive outcomes (Scruggs et al., 2010). This same study also showed that when the students were taught the academic measurement of content knowledge as a component of PBL instruction, it helped the students develop an interest in their education as it placed the power of assessment in their hands. When teachers have expected students to take feedback given to them and improve upon their work, students have an opportunity to clarify their thoughts, as well as reshape concepts that they might not have a complete understanding of through the rethinking and revision of their work and ideas.

Present Work to a Public Audience

Larmer and Mergendoller (2010) highlighted the importance of having someone other than a teacher assess the products in a classroom that employs PBL instruction. In

PBL instruction there are no final exams; however, the students are expected to present their work in an exhibition of learning. This encompasses a presentation of the work they have done to address the driving question of the project. During a final presentation of the students' learning, students will often present their work and ideas to an expert in the field or industry connected to their learning. At the school where I conducted my research, for example, this was often a person who has worked with the teacher to develop curriculum for the project work and therefore had familiarity with what has been taught as well as how the teachers connected it to the outside world beyond the classroom. This made the final presentation for the student a very high-stakes experience and promoted students to take their understandings and knowledge seriously. "When students present their work to a real audience, they care more about its quality" (Larmer & Mergendoller, 2010, p. 37). This was important to my proposed study because I found evidence that students with disabilities succeed in alternative forms of assessment like these in existing studies. Alternate curriculum assessments (i.e., public presentations of learning) for students with disabilities have offered opportunities to measure academic skills as well as social skills (Prestidge & Williams-Glaser, 2000) and have shown to be effective in producing positive change in student learning as measured by post-assessments of content knowledge (Kleinert et al., 1999). To ensure success for students with disabilities in PBL public demonstrations of learning, deliberate training of presentation skills, as well as practicing with students before their exhibitions might promote success in the presentations.

Special Education Principles and PBL Instruction

The Individuals with Disabilities in Education Act (IDEA) of 2004 stated the

purpose of the law as:

> Disability is a natural part of the human experience and in no way diminishes the right of individuals to participate in or contribute to society. Improving educational results for children with disabilities is an essential element of our national policy of ensuring equality of opportunity, full participation, independent living, and economic self-sufficiency for individuals with disabilities. (20 U. S. C. §1400(c)(1)

The goals that IDEA (2004) holds for students with disabilities should be accomplished through six principles that focus on students' rights and the responsibilities of the educational institution to enact these goals. These principles include (a) zero reject; (b) nondiscriminatory evaluation; (c) individualized and appropriate education; (d) least restrictive environment; (e) procedural safeguards; and (f) parental participation (Turnbull et al., 2007). Teachers implementing special education services in schools should have these four goals and six principles for its learners in mind as they develop classroom experiences as well as goals for students with disabilities. In the section below I will define these and describe how teachers can use PBL instruction to partly address the goals for students and principles undergirding IDEA.

Principles of IDEA

The first principle of IDEA (2004) that guides the education of students with disabilities is the principle of zero reject. This is encapsulated by the guidance that "students with disabilities may not be excluded, either physically or functionally from public education" (Turnbull et al., 2007, p. 56). This addresses the goal of providing educational opportunity for students with disabilities. The authors clarify this principle as

a directive to ensure that students with disabilities "should have access to the same resources for the same results" (p. 100). This meant that the focus of a program developed for a student receiving special education is to help the student have opportunities to "live in the *regular* world and be educated in regular programs, work in regular jobs, live in regular housing, and otherwise be more like than different from people without disabilities" (p.101).

The second principle that guides the education of students with disabilities in IDEA (2004) is the principle of nondiscriminatory evaluation. Turnbull et al. (2007) described that IDEA "requires a multidisciplinary, multifaceted, nonbiased evaluation of a child before classifying an providing special education for that child" (p. 120). The authors stated that the purpose of this principle is to ensure that students with disabilities are evaluated fairly and accurately so that underlying disabilities may be identified, and an appropriate individualized education program can be developed in the least restrictive environment (LRE).

The third principle of IDEA (2004) that guides educators to ensure the four goals of the law are enacted is the development of an individualized and appropriate education for students with disabilities. The foundation of this principle is the idea of schools providing an educational benefit to students with disabilities through the use of an individualized education program (IEP). The focus of this principle is the *appropriateness* of the educational experience for the student and it is achieved through attention to a process and benefits lens (Turnbull et al., 2007). The process lens of an individualized and appropriate education involves the school following the process of developing an educational program for a student with disabilities. This involves a non-

discriminatory evaluation, developing an IEP that meets the student's unique (individual) needs, and allowing the student to access the least restrictive educational environment to accomplish the goals of the IEP. The benefit lens that Turnbull et al. described was the idea that the plan enacted by the school had meaningful benefit for the student, not minimum benefit or maximum benefit.

The fourth principle that frames the goals of IDEA (2004) is the principle of the least restrictive environment (LRE) in which the student can access the general curriculum. Turnbull et al. (2007) argued that by maximizing inclusion and participation of students with disabilities in general education, the students will experience academic and social benefits through special education services. Access to the LRE for students with disabilities is founded in the constitutional right of due process of the law. In order to ensure equal opportunity to educational experiences, schools need to make certain first that special education services and supports are provided in the LRE and students are only placed in more restricted settings if they do not show educational benefit. If a student with disabilities is to be served in a setting other than the general education classroom, the school needs to demonstrate that they are justified in the placement through the lens of educational and personal benefit to the student in this more restrictive environment. The student is given due process of the law to prevent more restrictions placed than necessary for them to receive appropriate educational services.

The fifth principle undergirding IDEA (2004) is the principle of procedural due process. This principle ensures that if students with disabilities or families of those students feel that their student has been denied free appropriate public education (FAPE) in the LRE, that they have a means to question the nature of the special education

services provided that might be in violation of a student's rights (Turnbull et al., 2007). The directive of schools to provide special education services is required by law as interpreted through the 14th amendment to the constitution. Due process of the law is guaranteed by the 5th and 14th amendments (Turnbull et al., 2007).

The final principle that shapes IDEA (2004) and how it is implemented in schools is the principle of parent participation. The foundation of this principle is the idea that parent participation with the schools is essential to develop and implement the educational program of a student with disabilities based on the first four principles in IDEA (Turnbull et al., 2007). Parents and schools collaboratively develop an individualized plan through what Turnbull et al. described as a partnership. The partnership exists to create an IEP that promotes positive student outcomes and emphasize not only the rights of the students in special education, but the responsibilities of parents as a part of the process as well. One important aspect of parent participation that connects to the current study is the directive of the parent and the school to transition the participation of the education program more to the student as they approach the age of majority (i.e., 18) in order for the student to develop self-advocacy skills.

PBL instruction holds unique opportunities to address some of the goals for students receiving special education services. For example, the flexibility of PBL instruction in its essential component of voice and choice has the potential to support students with disabilities in addressing equality in educational opportunity for students through addressing the need for individualization of instruction. Since the voice and choice component of PBL instruction allows for options in what and how students learn as well as how students demonstrate their learning through non-traditional means (i.e.,

public demonstration or making something) students with disabilities can be easily accommodated in PBL instruction. Students with disabilities in inclusive PBL instruction have the opportunity to participate fully in general education instruction because of the flexibility of learning groups, flexibility in access points to complex project work, and flexibility in how students demonstrate their learning.

PBL instruction also holds promise to ensure a free appropriate education for students with disabilities through meeting a child's unique needs in order to prepare them for what IDEA (2004) characterized as further education, employment, and independent living. Since PBL instruction's foundation relies on classwork that is contextualized outside of the classroom, the potential exists for PBL instruction to connect to meaningful contexts that promote student understanding of employment and independent living skills.

PBL instruction emphasizes 21st century skills including creativity and innovation, critical thinking, problem solving, and communication and collaboration (Partnership for 21st Century Learning, 2008). As I discussed in the previous section about 21st century skills, these skills promote students learning skills necessary for future employment in the workforce. The U.S. Department of Labor (1991) suggested that skills necessary for the workforce could be learned in the context of typical instruction. PBL instruction not only holds this promise, it also directly emphasizes the skills that the U.S. Department of Labor suggests students should learn. This is especially important due to the higher incidence of underemployment and unemployment that people with disabilities experience when compared to their peers without disabilities. This also addresses the directive outlined in IDEA (2004) that students with disabilities need skills to address the

goal of economic self-sufficiency as they transition into adulthood.

The scope of PBL instruction allows for teachers to attend to some of the principles of IDEA (2004) that are appropriate for the classroom. In this section I identified how the foundations of PBL instruction address zero reject, individualized and appropriate education, and the LRE. These three principles of IDEA (2004) appeared to fit within the framework of PBL instruction and should be identifiable within the experiences of a student with disabilities in a classroom using PBL instruction methods.

Universal Design for Learning and PBL Instruction

Three principles undergird the implementation of Universal Design for Learning (UDL). These include (a) multiple means of representation; (b) multiple means of action and expression; and (c) multiple means of engagement (Rose & Meyer, 2002). These three aspects of instructional design exist as part of PBL instruction and hold potential to help students learn academic content and skills. In the following section I will explain how UDL fits within PBL instruction and how it holds potential to address needs for students with disabilities.

The first component of UDL that offers promise for students with disabilities is the multiple means of representation. This involves the students being able to perceive information in differentiated ways through teachers providing options for information presented through written and spoken language as well as teachers considering "how students best perceive information, how to present information in multiple ways, and if multimedia could make abstract concepts more concrete" (Kieran & Anderson, 2019, p. 1205). Multiple means of representation "gives learners various ways of acquiring information based on their individual learning style, experiences, and background

knowledge" (Jimenez et al., 2007, p. 45). For example, instead of students reading independently about a concept that they need to learn, teachers might use a video with guided notes that presents the information and then conduct a discussion in a small group to reinforce the concepts that the students need to learn. Jimenez and his colleagues further suggested that teachers understand student barriers to learning by being aware of students' skills and background knowledge. The background knowledge of a student connects to the PBL instruction idea of need to know as well as voice and choice. When students first start a project, they need to develop an understanding of not only the reason to learn the content in the project, but also identify what they need to know to develop the project. This involves the teacher guiding the student through a process of identifying the required knowledge they need to explore and ultimately address the project that they are creating solutions towards, then identifying deficits in the knowledge of the student in order to make a plan for learning. The students should also have voice and choice in how they are able to access information that they need to learn in the class as well as voice and choice in the actions necessary to learn the knowledge and skills necessary in a project. For example, a student might have multiple resources that are available for them when learning about a concept in the classroom. These might include videos, diagrams, and readings. The students might then have an option of completing many activities in order to learn the content knowledge and skills though physical, social, and independent activities.

The second component of UDL is the multiple means of action and expression. This involves teachers creating learning activities that are designed to promote student engagement and self-management of the learning process (National Center on UDL,

2013). Teachers promote multiple means of action and expression when they use multiple ways to formatively and summatively evaluate students through providing multiple options for students to demonstrate their learning through physical action, expression, and various means communication (Kieran & Anderson, 2019). Multiple means of expression "supports strategic learning and creates several alternatives for demonstrating what learners know" (Jimenez et al., 2007, p. 45). UDL promotes frequent feedback in learning that centers on students building academic skills as well as self-evaluation. Students also need to be actively involved in "making meaning of new information, using learning strategies, evaluating their understanding of class content, and monitoring their progress" (Kieran & Anderson, 2007, p. 1206). The PBL instructional component of voice and choice applies to multiple means of expression in UDL as well. Students have the ability to choose how they represent their learning and teachers have the option of assessing students through multiple means. The multiple means of expression component of UDL also connects directly to feedback and revision in PBL where teachers provide substantive feedback and require students to develop understanding of academic and contextual knowledge and skills through the process of revision of their work. Teachers in PBL instruction use regular feedback to address understandings and misunderstandings of content knowledge in order to address what needs to be learned to propose a solution to the driving question or tackle a smaller aspect of the learning to understand the larger project goals.

The third foundational component of UDL is multiple means of engagement. For teachers to develop student engagement through UDL they need to consider ways to promote student interest and perseverance with learning (Kieran & Anderson, 2019).

Further, multiple means of engagement not only connects the learning to students' interest, it also directs the learning in a classroom to offer appropriate challenges to increase motivation (Jimenez et al., 2007). This is of utmost importance in all students especially those with disabilities since achievement gaps can lead to students disengaging from learning and becoming discouraged with their experiences in school.

One of the purposes of UDL is to allow teachers to create appropriate goals designed to address the needs of a many different students and develop instruction that is responsive to individual differences (Rose & Meyer, 2002). The UDL concept of multiple means of engagement connects to the PBL instruction component of inquiry and innovation as well as voice and choice. In PBL instruction students are conducting inquiry on real-world concepts where the students have the opportunity to solve a problem or provide solutions for a problem that exists outside of the scope of the classroom. In PBL instruction inquiry involves choice for students' learning focused on student interest.

Designing instruction for all students, including those who have disabilities, using the principles of UDL helps teachers understand how instructional practices can impact access to knowledge and skill development for learners. A UDL framework for instructional design assists the educator in understanding that the development of the instructional and assessment practices can either create barriers to instruction or minimize them (Kieran & Anderson, 2019).

Assumptions of PBL Instruction and Students with Disabilities

It was important for me as a qualitative researcher to disclose my assumptions about students with disabilities engaging in project-based learning experiences. The

assumptions that I held during this study helped me understand my personal experience as well as my lens as a researcher while studying students with disabilities in a PBL instruction.

Based on Dewey and Kilpatrick's thinking for contextualized learning, students with disabilities have talents that may not have been developed and assessed in a traditional classroom. Most traditional classroom instruction is weighted heavily on traditional summative assessments (e.g., quizzes, chapter tests, essays) that rely heavily on students using writing to describe or demonstrate their learning. PBL instruction promotes alternative means of assessment through demonstrating, talking about, and displaying content learning through tangible products and evidence created to address a driving question.

Based on the research presented by Gillies and Ashman (2000) and Agran et al. (2001), collaboration can have positive effects on academic process skills (i.e., cooperation, peers helping each other, and problem solving). Students with disabilities may have difficulties engaging in group work. Collaboration, unless specifically taught to students, is difficult to do well. This might affect the academic outcomes of students with disabilities in classrooms using PBL instruction because so much of the work is done in collaborative groupings.

Students with disabilities might benefit from collaborative group work. Flippatou and Kaldi (2010) found that students with disabilities engaged in the learning process more in PBL instruction than in typical instruction. The authors suggested that learners with disabilities receive individualized instruction in remedial skills as well as instruction in cooperative learning to benefit from PBL.

Students with disabilities may be passive in inclusive settings like Flippatou and Kaldi (2010) discussed. Much like the identification of what a student is good at doing, the potential self-perceived stigma and lowered self-efficacy of many students with disabilities engaging in inclusive and collaborative settings might promote self-created barriers to a students' learning. Student passivity might create difficulties in classrooms implementing PBL instruction.

Students with disabilities may disengage in the challenging work required to solve a problem like Ferretti et al. (2001) discussed. The ability to stick with a project that is not going well can be challenging for anyone. In particular, student with disabilities might need to be monitored more closely to discern and ameliorate barriers that might impede their learning about a complex and challenging topic.

Students with disabilities are motivated to engage in problem solving when there is an authentic reason to learn what they need to learn like Ferretti et al. (2001) discussed. In order to address the post-school outcomes of students with disabilities addressed by the National Center for Special Education Research (2011), I feel that by having students understand how their work in the classroom connects to pursuits beyond school will positively impact the employability and life outcomes of students with disabilities.

Problem Statement

Students with disabilities have been greatly underrepresented in the literature examining PBL practices. There have been mixed outcomes for students with disabilities in the little research where my focal population has been included, and there has been little research that describes PBL instruction where the pedagogy of a school is entirely based in PBL. Because of the limited research examining outcomes for students with

disabilities in PBL instruction connected to the further limitation of few studies examining schools using solely PBL instructional practices, my study added to what is known about the effective use of PBL instruction.

The school in which I conducted my study implemented the essential components of PBL instruction throughout all curricula. This included inclusive education for all students as defined by The Association for the Severely Handicapped (TASH): "full membership, relationships, participation, and learning for all students with disabilities" within the general education classroom (TASH, 2016, para. 2).

Purpose of the Study

The purpose of this study was to describe the experience of students with disabilities engaging in PBL instruction through the entirety of a unit of study in a small charter high school that uses this instructional method exclusively to deliver content through integrated learning experiences. The primary question for my research was: How do students with disabilities experience PBL instruction in relation to their supports and interactions with instructional activities, materials and tools, and instructors and fellow students to learn project content?

The following research questions helped me understand this larger question:

1. When and in what ways do components of PBL show up in the classroom, instructional materials, and teaching and learning interactions?
2. How does the learning environment scaffold learning for students with disabilities?
3. How do students navigate learning in PBL instruction (i.e., what are students doing when they interact with learning materials and activities and how are

they interacting with teachers and peers to learn project content and skills)?

4. How do students demonstrate their learning of a new content skill in PBL instruction?

The research questions I have included above, and the methods I used to answer them, are outlined in Appendix A and described in Chapter Three.

Researcher Bias

I taught at the school of interest since it opened its doors. I have made PBL instruction a priority in my classroom pedagogy since this was required of me to serve all students. I was also in a relationship with the executive director, who was the co-founder of the school. I had a vested interest in making sure that this school was successful. I do believe that students with disabilities can be served in PBL instruction like the school I studied because I have seen students graduate who probably would not have graduated from another school. I have also seen students get pushed out of the school community by the challenges they faced in this school. Because of these main parts of my identity and my thinking, I needed to be careful to not attempt to show false-positive results in my study.

Students perceived me as a person of power in the institution. They responded positively to my authority and relationships I had with my colleagues. Students saw me as an educational leader, with the power to train new teachers as well as take care of problems when they arose through the course of a school day. I needed to be aware of this perception as I committed to implementing a research study at the school I have helped build.

I have also been taught through a graduate program where inclusive practices are

encouraged for all learners. This not only was emphasized to me in my training to become a teacher, but it is now how I teach. Because I have been teaching in inclusive settings for the last eight years and piloted inclusive settings before my current placement, I needed to be aware of my inherent bias toward viewing findings from the study in a positive light.

My thoughts on what comprises academic success encompassed the following beliefs and values I hold for learners. To me, academic success is student progress toward set educational standards based in Common Core Content Standards and Career Readiness standards, as well as individualized education plan (IEP) goals when applicable. In addition, I saw students interacting with others as an important part of academic learning.

To address my inherent bias as a researcher, I implemented the following components into my study. During the recruitment segment of the study, I enlisted the help of a school social worker who met with the students and teachers who expressed interest in the study after I described the research to help minimize any unintentional coercion on my part for them to participate. The social worker described to the potential participants that participation was completely voluntary, and that choosing to participate in or not participate in the study would have had no bearing on their performance grade in the class or employment for teachers. The completed consent forms were returned to the social worker in order to make sure that students and teachers did not feel uncomfortable in any way when giving the consent materials back to me.

I also attempted to further protect students from any perceived threats to their academic progress related to participating in the study by recusing myself from grading

their work if they were also students in a project I taught. This was possible since there were multiple teachers in each project, and this did not create an undue burden on my colleagues while adding a layer of protection for the student participants.

I showed my findings to a critical friend colleague who knew PBL instruction and special education well. She also had a connection to the school. This helped make sure that I was not trying to show false positives through my interpretation of the data.

In order to protect the teacher participants from any retaliation from supervisors, I first discussed my findings with the teacher participants and asked their permission to share any findings with the administration. This helped teacher participants have voice in how the interpretations for the study were disseminated.

I also used triangulation to address multiple means of documenting evidence for study findings in order to minimize potential bias for finding positive outcomes. The study employed interviews with students and teachers; targeted questioning; observations of students and teachers in classroom activities; examination of teacher curriculum materials; and examination of artifacts of student learning.

Definitions

For the purposes of clarity in this study I defined the following terms:

Exhibition: a summative assessment of the learning of a student in a project that is done through a final presentation, completed either individually or in a small group.

Inclusive education: a classroom setting where students with IEPs are being taught in the general education classroom using modifications and accommodations based on the IEP document.

Collaboration: students and teachers work together to achieve a pre-set goal based

in common definitions of success and individual accountability within the work in a project.

Interview: primary researcher asking oral questions of a participant, either student or teacher, at the beginning and end of the study that discuss the questions included in Appendix B or Appendix C.

Perceive/Perception: people reporting their experiences and activities through narrative interview and narrative interview anchored in artifact description of the phenomenon of interest.

Project-based learning unit of study: a 12-week project that has smaller components of study to culminate in the development of an answer to an essential question for the class.

Project: one 12-week interdisciplinary class that uses the components of PBL instruction to answer a large question through the production of a final product to be exhibited to peers, teachers, and external guests at the conclusion of the project.

Project-Based Learning (PBL) instruction: students engage in integrated, interdisciplinary projects. Students use content-area studies to solve problems or create a piece of work that solves a problem proposed by a need defined usually at the beginning of the project.

Targeted questioning: an informal discussion between me and a student, or group of students, at the end of a project meeting in which I ask questions about actions I observed, with the intent to understand what students learned in the day's lesson and how they learned it.

Chapter Two

Research Review

In this section I present literature I reviewed examining the experiences of students with disabilities in Project-Based Learning (PBL) instruction. Doing this review gave me a good foundation for the design of the current study. The overarching questions I had for this review were about PBL's effectiveness in producing positive academic outcomes for students with disabilities and more closely examining the experiences of students with disabilities in PBL instruction. Since my study will focused on an existing school that implemented PBL, I chose to omit the research on Problem-Based Learning, as described by Barrows (1996), for this review. Problem Based Learning, although related to PBL, is a separate method for teaching that is not employed by the school of study and is smaller in scope than Project Based Learning.

In order to understand the full scope of research examining PBL instruction, I started with a brief examination and discussion of studies that included typically developing students. Understanding this body of research helped me then frame the research for students with disabilities with recommendations for improving student outcomes. I examined these studies to determine what types of measures of academic outcomes researchers used, factors that affected student outcomes, and finally, the types of qualitative methods researchers employed in their investigations of students engaging in PBL instruction. This helped me understand any common successes and struggles for students with and without disabilities in such settings, and it also helped me in designing my study.

PBL with Typically Developing Students

Does PBL positively impact student academic achievement for all students? To expand my search to answer this question, I first reviewed literature that discussed academic measures for students without disabilities experiencing PBL instruction. As stated before, research including students with disabilities in PBL instruction is limited in number and scope, so I began with a brief review of intervention studies that included typically developing students experiencing PBL instruction. I was interested in how researchers measured student academic success in these studies and in factors they identified as affecting student outcomes. This information helped me select appropriate measures for my study to understand how PBL instruction may affect student academic performance. My targeted search and subsequent review were not representative of all available PBL literature but was focused to find and analyze a variety of studies that included measures of academic performance and examination of factors that affect student outcomes.

Because I am very concerned with teachers using the most effective means of educating students with disabilities in order to produce positive academic results, I was also interested in other factors in PBL instruction that might influence student academic performance. Many researchers have examined various aspects of PBL instruction with typically developing students. Exploring their findings of how these aspects of project-based learning do and do not promote academic success for students is a good place to start in understanding what aspects of PBL instruction might be more or less effective students with disabilities. Aspects of PBL instruction examined in this literature have included parent perceptions of the effectiveness of PBL (e.g., ChanLin, 2008; Hong et al., 2013); teacher perceptions; (e.g., Chang & Lee, 2010; Hong et al., 2013; Kaldi et al.,

2011); and student perceptions/attitudes (e.g., Chang & Lee, 2010; ChanLin, 2008; Kaldi et al., 2011; Seet & Quek, 2010; Summers & Dickinson, 2012).

Search Method

I accessed Ebsco Host databases for the purpose of this literature review. I queried the subject terms "project based learning" and applied the following inclusion criteria: (a) academic journals only; (b) English language articles; (c) intervention studies (i.e., examined the effect of PBL instruction on student outcomes), and (d) studies that included participants ages birth through 18 years of age who did not have identified disabilities.

The search returned 284 articles that referenced "project-based learning" in the subject heading. When I applied the inclusion criteria (see above) to the list, I found a total of 39 studies. From this list of 39, I conducted a further search of each abstract to omit articles that did not describe an intervention study using PBL instruction methods in a K-12 setting. Thirty-three articles met the inclusion criteria.

In order to fully understand the various ways in which researchers have used to study students in PBL instruction, I chose to analyze these 33 studies using the following factors: (a) number of participants, (b) participants' age, (c) design of study, (d) types of measurement tool(s), and (e) a summary of major findings. This information is outlined for each study in Table 1.

Table 1

Studies that Included Students Without Identified Disabilities

Authors	Number of Participants	Age/ Grade level	Design	Measures	Results
Apedoe et al. (2012)	271 students	9-12 grade	Quasi-experimental with survey with control group	Pre-test/ post-test (chemistry); teacher survey	Large group size negatively affected the knowledge gains of students in advanced classes. Group size did not affect the knowledge gains in typical classrooms. Teachers preferred smaller groups.
Beckett et al. (2016)	1097	9^{th}-10^{th} grade	Survey with observations	Modified feedback survey administered to STEM students	PBL instruction practices facilitate engagement of students when implemented with students whose ethnicities are underrepresented in STEM careers. Students reported that projects were more unique than typical classrooms and self-reported higher levels of engagement in PBL projects than typical classroom instruction.

Authors	Number of Participants	Age/ Grade level	Design	Measures	Results
Capraro et al. (2016)	3,801 students	9th – 12th grade	Quasi experimental	Posttest; Standardized tests in STEM; Observation instrument	Students who were in classes using PBL instruction where the teachers implemented the unit of study with the greatest fidelity showed the highest academic gains based on standardized test scores. Qualitative data showed that teachers perceived PBL as having non-academic positive results for their students.
Chang & Lee (2010)	262 students (geography and English classes); 3 teachers	10th grade (phase 1); 11th grade (phase 2)	Mixed Methods (Case Study)	Pre-posttest; Teacher journals; in-class handouts; interviews with teachers; student progress reports; student questionnaires; student interviews.	Students in classes using PBL instruction showed greater academic gains in than control group. Students were interested in continuing to learn through PBL instruction. Students perceived that PBL instruction helped them learn. Teachers perceived that students learned better through PBL instruction.
Chang & Tseng (2011)	90 students	8th grade	Quasi experimental with control group	Pre-test/ Post-test in computer knowledge	There was no difference in academic performance between PBL instruction and control groups based on the pre/post test. Student perception of knowledge gained was greater in the PBL group than the control group.

Authors	Number of Participants	Age/ Grade level	Design	Measures	Results
ChanLin (2008)	Unstated number of students in Taiwan	5th grade	Case Study	Interviews; field notes; teacher journals; student work (science)	Students who engaged in a PBL instruction experiences noted positive attitudes toward their learning. Students perceived that learning basic skills and scientific processes are important to subsequent learning.
Cheng et al. (2008)	1,921 students	HS	Survey	Questionnaire about multidisciplinary projects;	Students had a higher group efficacy than self-efficacy if they experienced self-reported high-quality group experiences.
Culclasure et al. (2019)	2362	k-12	Quantitative/ Qualitative	Observations; surveys (teachers and students); standardized test scores	Participants in PBL and non-PBL instruction showed no significant differences between academic outcomes or behavioral outcomes. Students using PBL instruction showed better performance on measures of social-emotional skills.
Demirci (2010)	6 students	6th grade	Case study	interviews; observations in science class; artifacts from science class	Students enjoyed PBL instruction activities more than typical curriculum.

Authors	Number of Participants	Age/ Grade level	Design	Measures	Results
Edmunds et al.(2017)	1,575 Students; 32 teachers	9th – 12th grade	Mixed Methods (Case Study)	Student surveys in STEM class; STEM teacher logs; STEM class observations	PBL instruction is associated with higher levels of rigor than comparison group across all three measures. Academic rigor can be present in the absence of PBL instruction, and PBL instruction can be implemented with low levels of rigor.
Erdogan et al. (2016)	565 students	8th, 10th, and 11th grade	Quasi experimental with multiple implementation classes	Standardized tests in STEM	Full STEM PBL instruction implementation showed student improvement in measures across both ethnicity and gender. Partial implementation is not as effective as full implementation.
Ferretti et al. (2001)	59 students w/o disabilities; 28 students w/disabilities	5th grade	Quasi experimental with no control	Social Studies knowledge test; attitudes scale; observations	Students without disabilities learned more based on post-test results than their peers with disabilities. All students gained understanding of bias in readings.
Han et al. (2016)	528 students in intervention; 2668 in non-intervention	9th – 12th grade	Quasi experimental with no control	Standardized tests (Math)	STEM PBL instruction positively influenced Hispanic students' achievement in mathematics based on standardized tests, but not students defined as “at-risk”.

Authors	Number of Participants	Age/ Grade level	Design	Measures	Results
Holmes & Hwang (2016)	532 students	8th and 9th grade	Intervention/ control comparison	Math standardized test scores; online survey scores; observations; interviews	Two-year study that showed that PBL instruction positively impacted the achievement gap between students identified as minority and non-minority students.
Hong et al. (2013)	62 students; 3 teachers; 23 parents	Jr HS	Case Study	Interviews; after school science club observations	Extracurricular club implementing PBL instruction through a wooden robot build showed that PBL instruction had positive effects on parent's attitudes toward program, collaborative problem-solving, and students' attitudes toward science.
Hsu et al. (2015)	54 students	7th grade	Quasi-experimental Intervention/ control comparison	Science essay analysis; verbal argument analysis	Computer assisted PBL instruction methods helped students develop argumentation techniques and positively impacted academic outcomes.
Hsu et al. (2016)	42 students (US: 21 in intervention; 15 in control; Taiwan: 21 in intervention; 11 in control	7th grade	Quasi-experimental Intervention/control comparison	Science essay analysis; verbal argument analysis; Observations	Both American and Taiwanese students' scientific knowledge of alternative energy were positively affected by PBL instruction. Cultural differences might impact how students engage in PBL instruction.

Authors	Number of Participants	Age/ Grade level	Design	Measures	Results
Hugerat (2016)	458 students in Israel	9th grade	Survey	Science class Questionnaire	Students reported that relationships between students and between students and teachers were positively impacted by PBL instruction practices. Also, students reported that they enjoyed PBL instruction class work more than traditional instruction practices.
Kaldi et al. (2011)	94 students in Greece	4th grade	Mixed Methods (Case study)	Science knowledge test; attitude scale; teacher/ student interviews; classroom observations	PBL instruction positively impacted student content knowledge on sea animals. Students developed positive attitudes toward self-efficacy and task value.
Kalyoncu & Tepecik (2010)	61 students	8th grade	Quasi experimental with control group	Visual arts pretest/ posttest	Study found a significant difference between pre and posttest measures of knowledge in visual arts in the PBL instruction group, but not in control group.
Lee & Tsai (2004)	156 students	5th grade	Quasi-experimental with no control group	Researcher-designed science knowledge transfer measures	Students participating in a web based PBL instruction learning environment showed that different thinking styles have different results in transfer of knowledge. Executive thinking styles. Different thinking styles should be encouraged in group work in PBL instruction.

Authors	Number of Participants	Age/ Grade level	Design	Measures	Results
Lou et al. (2014)	72 female students in Taiwan	1st and 2nd year HS	Focus group design with questionnaire	Questionnaire to STEM students; STEM student focus group	STEM PBL instruction has positive effects on students' "imagination and learning effectiveness and attitudes as well as on their strategic performance in problem-solving, collaborative learning, and online behavior".
Lu & Law (2012)	186 students	Jr HS 13-14 yr	Case Study	Time logs; response to other students' humanities wikis; prior academic records	Time working on their own wiki, commenting on work of others, and high performance in the class previous to the PBL instruction unit were predictors of academic success in this PBL instruction.
Morales et al. (2013)	31 students	HS	Case Study	Video recordings of design class; classroom observations of design class; interviews	PBL instruction can be effective with minimal teacher guidance. Some newcomers had problems adjusting and need small tasks to start PBL instruction project.
Ozdener & Ozcoban (2004)	75 students	6th grade	Quasi experimental with control group	Computer content knowledge pretest/ posttest	PBL instruction has a positive effect on student success in computer content knowledge. Choosing the teaching method that fits learners is important.

Authors	Number of Participants	Age/ Grade level	Design	Measures	Results
Petrucco (2013)	20 male students	16 yo	Case Study	Survey of science students; observations in science class	Service learning PBL instruction promotes positive motivation for students based on end survey. Students felt that they learned how to collaborate online and understand cellular communications and EM pollution more through this project than using traditional methods.
Seet & Quek (2010)	68 students	HS	Survey	Questionnaires of exchange students in humanities curriculum	Students liked the PBL instruction experience more than typical classroom experiences. Instructor Support and Social Presence were best predictors of attitudes towards PBL instruction.
Smith (2016)	3 students (1 elementary; 1 middle; 1 high school)	3rd, 7th, and 10th grade	Case study in after-school program	Reflective video made by STEM students in after-school program and focus group of STEM students	Students in PBL instruction afterschool program showed increases in cognitive skills (i.e., researching, brainstorming, and critical thinking).

Authors	Number of Participants	Age/ Grade level	Design	Measures	Results
Summers & Dickinson (2012)	200+ students	9th – 12th grade	Quasi experimental with control group; qualitative triangulation	Pre/post test; Standardized test (Social Studies); interview	Long-term knowledge acquisition was promoted in wholly PBL instruction school greater than traditional school as measured by standardized social studies tests. Freshmen in PBL instruction did not like the peer-accountability and rule enforcement that takes place. The PBL instruction group had higher levels of advancement to next grade level than students in traditional school
Tsai et al. (2015)	96 students	6th grade	Quasi-experimental with qualitative triangulation with control group	Elective digital media class content knowledge pre/post-test; interview	PBL instruction methods supported computer skill acquisition greater than traditional methods of instruction Teacher help when starting new learning in PBL instruction improves the learning of students.
Wang et al. (2016)	176 students in Taiwan	11th – 12th grade	Quasi-experimental with no control group	Science and computer knowledge pre/post-test; questionnaire (2)	Learning achievement, learning attitudes and 5C (communication, collaboration, critical thinking, complex problem-solving and creativity) abilities of students can be enhanced through the implementation of PBL instruction.
Wuttisela et al. (2016)	25 students; 15 teachers; 5 experts	10th grade	Quasi experimental with no control group	Computer class student reflection	Students trained in giving feedback in a PBL instruction had positive impacts on their academic social skills in a science class. Students felt better about giving feedback after the training.

Authors	Number of Participants	Age/ Grade level	Design	Measures	Results
Zusevics & Johnson (2014)	268 students	HS	Quasi experimental with control group	Health student questionnaire (pre, mid, post)	PBL instruction in a classroom intervention did not affect the students' perceptions of "hope" in students of color A single course in PBL does not increase students' perceptions of "hope"

Based on careful reading and rereading of the 33 studies, I chose to organize and describe their findings using four main categories: (a) standardized academic measures; (b) teacher-created measures; (c) studies that included qualitative methods and measures; and (d) recommendations for implementation of PBL instruction arising from study findings. I chose to include qualitative measures as a category of discussion since my proposed study will use qualitative measures through a case study. At the conclusion of the Findings section, I included a discussion on the overall efficacy of the pedagogy based on the reviewed literature.

Findings

Within the 33 studies there were a total of over 12,000 participants ranging from elementary school age through high school. Twenty studies included students in high school (i.e., ninth through twelfth grade), 12 studies included middle school students (i.e., sixth through eighth grade), and five studies included elementary school students. Some studies included both middle and high school students so the total number of studies described is not 33 (e.g., Erdogan et al., 2016; Holmes & Hwang, 2016); and two studies included all three levels (i.e., Culclasure et al., 2019; Smith, 2016). Six studies used standardized tests as a measure of student success in PBL instruction (i.e., Capraro et al., 2016; Culclasure et al., 2019; Erdogan et al., 2016; Han et al., 2016; Holmes & Hwang, 2016; Summers & Dickinson, 2012). Seven studies used teacher or researcher created pre- and posttests of academic knowledge (i.e., Apedoe et al., 2012; Chang & Tseng, 2011; Ferretti et al., 2001; Kalyoncu & Tepecik, 2010; Ozdener & Ozcoban, 2004; Tsai et al., 2015; Wang et al., 2016). Most used qualitative measures to help triangulate effects of PBL (e.g., ChanLin, 2008; Hsu et al., 2016). In general, 30 of the 33 studies found

positive effects of PBL instruction on student academic outcomes, that students in these classrooms liked PBL instruction, and that students in classrooms that used PBL instruction improved their ability to talk about their own learning. Two studies (i.e., Chang & Tseng, 2011; Zusevics & Johnson, 2014) found neutral effects. Chang and Tseng (2011) found no significant difference in student achievement on academic assessments of computer knowledge between the PBL instruction group and the control group (i.e., neutral effects for PBL interventions), while Zusevics and Johnson found that perceptions of hope, as rated by a Likert scale, were not positively impacted by PBL instruction.

Several factors appear to have influenced whether or not students demonstrated positive academic progress in PBL instruction. In the following sections I have described and discussed major findings through the four categories from the reviewed studies (i.e., standardized academic measures, teacher-created academic measures, qualitative measures, and recommendations).

Standardized Test Measures of Academic Outcomes. six studies included in this literature review used standardized test measures as indicators of student academic outcomes in PBL instruction. Four of these studies used standardized test measures in STEM areas (e.g., Capraro et al., 2016; Erdogan et al., 2016; Han et al., 2016; Holmes & Hwang, 2016), one in English language arts and math (Culclasure et al., 2019) and one used state and district standardized test data in social studies (e.g., Summers & Dickinson, 2012) as measures of students' academic outcomes in PBL instruction.

Teacher Created Measures of Academic Outcomes. A total of eight studies included in this review used teacher-created assessments in the form of pretest and

posttest measures of academic skills (e.g., Apedoe et al., 2012; Chang & Tseng, 2011; Ferretti et al., 2001; Kalyoncu et al., 2010; Tsai et al., 2015; Wang et al., 2016) or other teacher created academic measures such as multiple-choice and open-ended answer tests of content knowledge, portfolio assessments, and rubrics assessing student products (e.g., Kaldi et al., 2011; Lee & Tsai, 2004).

Some reviewed studies examined whether one form of teacher created assessment was more effective than another. In one study involving two separate groups in computer classes using PBL instruction, Chang and Tseng (2011) found no significant difference in assessed academic content knowledge in computer classes between students who were assessed with a portfolio at the end of a PBL unit of study and students experiencing PBL instruction assessed with traditional means (e.g., multiple-choice and open-ended question assessments of learning).

Even though there was no significant difference between the academic content knowledge gained by students experiencing PBL instruction being assessed through portfolio or teacher-generated assessments (Chang & Tseng, 2011), the students' perceptions of what they had learned differed. Students in the portfolio assessment group perceived their growth in content knowledge as deeper than the students assessed using more traditional tests. This suggests that PBL instruction can be effective in producing academic gains and those gains in content knowledge can be detected on a variety of teacher created assessments. It also suggests that portfolio assessment may be a better assessment tool than traditional test measures if the goal is for students to also develop a deeper understanding of what they have learned than traditional test measures. This is an interesting finding since summative assessment of learning similar to a portfolio

presentation through the presentation of a project final product is not only a component of PBL instruction (i.e., public presentation of knowledge), but based on the findings from this study, for most students, the academic knowledge should show up in more traditional assessments as well.

Ferretti et al. (2001) found that students scored higher on teacher created posttest measures of social studies (i.e., a unit on the American West) content knowledge after the implementation of PBL instruction methods. The positive effects on content knowledge were seen in both students with and without disabilities; however, the group of learners without disabilities showed higher post-test improvement than their peers with disabilities. This suggests that PBL instruction is effective for all learners, but students with disabilities might need additional help beyond what would create positive results in a traditional setting.

In the realm of visual arts, Kalyoncu and Tepecik (2010) used teacher-created pre and post-test measures to demonstrate that PBL instruction was as effective than typical (business as usual) instruction in building visual art content knowledge. The authors also found that creative thinking, problem-solving skill, and academic risk-taking levels were higher in the group of students in the PBL instruction visual arts class than those in the traditional visual arts class. This finding was tempered by findings that the gains of students on visual arts post-test measures were not significantly different than the pre-test in the group who experienced typical instruction. The additional benefits of increased problem-solving and academic risk-taking skills in the group experiencing PBL instruction, demonstrates that PBL instruction not only positively affected content knowledge but also promoted other areas of growth (i.e., 21st century skills).

Studies Including Qualitative Measures. 17 of the 33 studies included in the review of research used qualitative measures to understand the experiences of students experiencing PBL instruction. This is of particular interest to me because I used a case study design to conduct my study and used qualitative measures to describe and understand students' experiences in PBL instruction. Researchers in the reviewed studies found a variety of positive student effects in many different settings using a range of qualitative measures including surveys, observations, interviews, and assessment of student-created project products. These 17 studies also found positive impacts on student collaboration skills, problem solving, and metacognitive growth in a variety of PBL instruction with students from elementary to high school. In the following section I will first discuss the types of qualitative measures found in these studies, and then I will discuss the outcomes of these assessments.

Interviews. Eight of the sixteen studies used interviews as techniques for understanding both teacher and students' perceptions and experiences in PBL instruction. Chang and Lee (2010) found that teachers reported their students as learning more effectively in classes using PBL instruction than in typical lecture classes and also perceived that they (teachers) did not have to spend more planning time when using PBL than when using traditional instruction in order to have students experience these positive effects.

ChanLin (2008) found that teachers perceived their own learning as a critical part of PBL instruction as a way to help students understand their learning. "They taught us to reexamine the way we examined and thought about the world" (p. 63). This pointed to the importance of teachers being a part of the learning experience as well and helps

teachers understand the importance of being an active part of the learning process in order to promote student success. Demirci (2010) noted that students interviewed in his study perceived their learning as more enjoyable in PBL instruction than in other types of instruction that they had experienced.

The findings from the two studies mentioned above showed that academic measures that teachers might use in their classrooms do not capture the whole experience that both the teachers and the learners may have in PBL instruction. These two studies, as well as the other studies that used interview methods to help understand the experiences of students and teachers in PBL instruction, provided precedence and justification for the use of interviews for me as a researcher trying to understand the experience of students with disabilities in PBL instruction.

Other Qualitative Measures. Other measures for qualitative analysis were used by researchers in the reviewed studies as well and show a more complete picture of outcomes beyond the academic ones. These include class observations (e.g., ChanLin, 2008; Demirci, 2010; Ferretti et al., 2001; Holmes & Hwang, 2016; Hong et al., 2013; Hsu et al., 2016; Kaldi et al., 2011; Morales et al., 2013; Petruco, 2013); teacher logs (e.g., ChanLin, 2008); surveys or questionnaires (e.g., Chang & Lee. 2010; Culclasure et al., 2019; Demirci, 2010; Edmunds et al., 2017; Feretti et al., 2001; Hugerat, 2016; Petruco, 2013; Seet & Quek, 2010; Wang et al., 2016; Zusevics & Johnson, 2014) as well as analysis of student work (e.g., ChanLin, 2008; Demirci, 2010; Hsu et al., 2015, 2016; Smith, 2016; Wuttisela et al., 2016).

Since there are a number of studies that used qualitative methods to understand the experiences of students and teachers in classrooms using PBL instruction, I looked to

these studies for guidance in setting up the interviews, observations, and student work analysis for my current study. I also examined how these researchers used qualitative measures to assess of outcomes other than academic.

Outcomes Studied. Capraro et al. (2016), Chang and Lee (2010), and Kaldi et al. (2011) discussed teacher and student perceptions of PBL instruction. These studies showed that teachers of typically developing students saw positive value in implementing PBL instruction with their students not only for academic gains, but also for social skills gains (i.e., collaboration and motivation). Capraro et al. (2016) found that teachers overwhelmingly perceived that PBL instruction positively affects student academic achievement, and that PBL instruction also has social benefits for students. In a STEM class setting, Capraro et al. found that teachers perceived that PBL enhanced engagement for students who were not typically engaged in the activities in the classroom.

Chang and colleagues (2010) found positive teacher perceptions as well. In this study teachers reported that students were able to develop deeper understandings of the process of learning when compared to their perceptions of typical instruction for students. Based on this positive perception, teachers in this study also reported that the additional time that it took to implement PBL instruction was well spent and did not detract from the learning that they perceived that the students should achieve in their classes. Kaldi and colleagues (2011) mirrored these findings that teachers felt that their planning time was well spent when students developed skills related to “academic performance, motivation, cooperative learning, and engagement in the learning process” (p. 46).

Petrucco (2013) found that students using PBL instruction in a service-learning class to study digital citizenship developed positive motivation and improved

collaboration skills with other students when studying digital signals and their impact on the community. In the Hong et al. (2013) study, students in an after-school science club improved collaborative problem-solving skills and were more highly engaged when using PBL than when in classrooms using traditional pedagogy.

Morales et al. (2013) found that PBL instruction could be implemented with minimal teacher-guidance once students have started projects. This finding is encouraging because after the beginning of a project, or a daily work plan, a teacher can transfer from initiating the work (i.e., providing structure, explaining, prompting) to helping students who need extra support.

Non-traditional means of assessment themselves can also promote students ' understanding of their own metacognitive growth (Smith, 2016). In Smith's study students were assessed through a reflective self-created video that highlighted the students' learning. Assessments like these offer promise to students in classrooms using PBL instruction to help them describe their own learning. Looking to research like this will offer teachers designing PBL instruction an opportunity to rethink how they assess students in such a complex and integrated setting.

Together, the studies described in this section highlight the usefulness of PBL instruction in developing social skills and increasing student engagement in complex problem solving in an engaging setting. They also suggest that PBL instruction fosters students' autonomous learning.

Summary. The literature I reviewed suggested that PBL instruction promoted a variety of positive, non-content knowledge effects for students as well as academic content knowledge. This brief discussion pointed to the importance of students'

perceptions of their own learning.

Recommendations for Implementation of PBL Instruction. Most of the reviewed studies showed a positive impact of PBL instruction on student academic success using a variety of measures. For example, the four studies that included over 1000 students (e.g., Beckett et al., 2016; Capraro et al., 2016; Cheng & Lam, 2008; Edmunds et al., 2017) showed that PBL instruction can result in positive outcomes for typically developing students when the teacher attends to a few specific factors. The factors identified in these studies as ones that help teachers implement PBL instruction and improve student experiences were (a) improving implementation fidelity of PBL instruction methods (Capraro et al., 2016); (b) using digital ways of presenting and representing learning (Beckett et al., 2016); (c) teacher facilitation of group work (Cheng et al., 2008); and (d) teacher use of PBL instruction experiences that promote academic rigor (Edmunds et al., 2017). These factors are described below.

Capraro et al. (2016) found that when PBL instruction methods were implemented with fidelity, based on district training of STEM PBL instruction over a total of three-years, students in the intervention group experienced greater gains on STEM using standardized test measures of academic success as compared to the students who experienced the lowest fidelity of implementation of PBL instruction. The group who experienced low implementation fidelity of PBL instruction methods in their instruction experienced negative growth on standardized tests measuring STEM knowledge when compared to the control group. This finding supported the point that PBL instruction is not just a method of teaching that lacks structure. It requires deliberate training at the school level to be implemented well and have desired results on the learning of students;

otherwise, it can negatively impact student learning.

Another factor affecting student outcomes in classrooms that use PBL instruction was how students perceived the importance of a task or how it relates to what they are studying. Beckett et al. (2016) used technology to implement STEM focused PBL instruction. They used student self-report surveys to describe student engagement and interest in PBL methods during this project. Students in the classes using PBL instruction reported that the projects were "engaging, interactive, challenging, and encouraging for in-depth and meaningful learning of science content knowledge" (p. 999). Students reported that they liked doing projects that connected to their day-to-day lives, and that they enjoyed taking on the role of an engineer as a designer. The researchers in this study found one section of the project where the students were not engaged in the learning activity. This happened when a novice teacher was using videos to convey content knowledge of global warming issues. The observers in this class saw the same students who were highly engaged in other areas of the project showing inattentive behaviors and disruptive behaviors during this section of learning. The authors argued that this finding shows that when students do not have an understanding of the importance of a task in PBL instruction that they will not engage fully in the work.

Facilitating groups can be a challenging aspect in any learning environment and this factor was also found to affect outcomes in PBL instruction. Cheng and Lam (2008) studied how heterogeneity of groups and teacher management of groups affected the efficacy of group work in PBL instruction where students chose which problems they studied. Of particular interest was their finding that when group interactions were monitored by the teacher, the perceived efficacy of the groups, based on student self-

report, was higher than for groups who were not monitored for group interactions. High performing students in poorly monitored groups reported that their group was not effective at completing their work and saw their own personal efficacy as higher than that of their group members. Low performing students perceived higher group- than self-efficacy whether the groups were monitored or not monitored for group interactions and collaboration. Interestingly in this study, findings suggested that it is more important to monitor and facilitate group progress than it is for the teacher to ensure the groups have a variety of students that complement each other's strengths or have a variation in gender within the groupings. What this tells us about PBL instructional grouping is that the need for the teacher to closely monitor group work and facilitate group interaction in order to complete work is greater than ensuring that the groups are mixed or same gender and heterogeneous in other measures.

Another issue related to group facilitation connected to the amount of teacher management of students' projects versus student management of their project work. Tsai et al. (2015) found that teacher initiation of work (i.e., helping students to start their work during project time) was more effective in projects being completed than allowing students to self-manage their own time and project work. Teacher management of projects was an important factor for me to consider when looking at a classroom using PBL instruction in this study based on the findings presented above.

Other issues related to grouping appear to affect student outcomes in PBL classrooms. Apedoe et. al. (2012) found that group size in chemistry PBL instruction might affect academic success. In advanced chemistry classes where PBL instruction was implemented, students who worked in pairs performed better than students who worked

in a group of three or four students. Interestingly, this effect was not seen in beginning chemistry classrooms in this same study. In these classes' students' academic knowledge, as measured by a teacher created assessment, showed no differences based on the size of student's groups.

Another study examining PBL instruction in computer instruction (i.e., Ozdener & Ozcoban, 2004) found improved student outcomes when students' collaborative groups were composed of students with differing dominant intelligence fields (i.e., multiple intelligences). This finding suggests that heterogeneous groups (i.e., grouping a variety of learners together for project work) promoted positive academic outcomes.

Edmunds et al. (2017) studied how academic rigor related to the implementation of PBL. They found that rigor can be present in PBL instruction, and it also can be lacking. Edmunds et al. recommended that PBL should be implemented using complex topics that reflect the core concepts of a discipline in order to promote rigor. Instructional activities should ensure that the students are engaging in high level thinking and should support them to explain their thinking as they move through the learning process. This means that instruction in which students do a simple project should not be described as PBL. Positive academic outcomes require more than just engaging activities. PBL instruction needs careful attention to the teacher's role as a facilitator and generator of experiences that push students to synthesize and analyze what it is that they are learning in order to develop a deep understanding of the content knowledge that is needed to complete a project.

Overall, from this section of the literature we can see that PBL instruction group work needs to be closely monitored by the teacher in order to create the environment

necessary to develop deep understandings of the project work and how a group needs to collaborate to get work done. Projects themselves are interesting and engaging to students who are not used to learning through them, so it is up to the teacher to guide the students through the experience if we expect PBL instruction to develop academic learning as well as contextualized learning.

Conclusion

Overall PBL instruction has been shown to be effective in increasing academic knowledge of typically developing students and has promoted positive impacts on other skills related to collaboration and critical thinking. The research review I conducted to examine this showed over 30 studies associated PBL instruction with positive outcomes for students without disabilities. This overwhelming support of PBL instruction in typically developing students helped me create an argument for the use of PBL instruction in classes with students with disabilities. Based on the available research located through this research review I found positive impacts for over 10,000 students. While this does not represent an exhaustive search for all of the available research in PBL and other inquiry-based methods for teaching, it did show a clear positive trend: students do well academically in PBL instruction; students like the experiences in PBL instruction; and students can talk about their learning (i.e., metacognition) in PBL instruction. Based on these results I concluded that further research is needed in PBL instruction for students with disabilities. The research I found for students with disabilities in classrooms using PBL instruction is included in the next section.

Research Review of Studies that Included Students with Disabilities in PBL Instruction

In order to evaluate the existing research examining the experiences of students with disabilities in PBL instruction, I began by exploring the available databases through Libraries Worldwide at my local institution. This database accesses over 400 active databases including academic databases. I searched Educational Research Complete databases using the key terms “project-based learning” and “disability” within all text. The reason I wanted to start with such a large search is because the term project based learning has been used to represent many different experiences for students that might not fit with the definition that Larmer and Mergendoller (2010) have created and that the school for the present study uses as a framework for learning. To help me understand the impact of PBL on academic outcomes of students with disabilities, I applied the following inclusion criteria to these entries: The study was (a) categorized as being published in a peer-reviewed journal by the database; and (b) categorized as including students in a kindergarten through twelfth-grade setting. The initial results included 327 English-language scholarly journal articles.

To narrow the pool of articles to those with the specific topic of students with disabilities in PBL instruction, I next conducted a title search for the keywords “project” and/or “disability, disabilities” of the initial 327 returned articles to determine if the contents of the article related to students with disabilities in a project based learning classroom. This narrowed the results to 29 studies with “project” in the title and 24 with “disability” in the title. This resulted in a total of 59 articles. I next removed duplicate titles and then further limited the articles to include only studies in which participants were students in K-12 settings.

I then eliminated one book and four dissertations from the list, then closely

examined the abstracts and methods of the remaining 53 peer-reviewed articles. In order to determine if the article included students with disabilities, I applied key word searches to the text of the studies to determine if any of the following terms were present: (a) disability; (b) disabilities; (c) special education; (d) exceptionality; (e) exceptionalities; or (f) IEP. For the purposes of this research review I excluded studies that took place in any setting other than K-12 (e.g., Boulden, 2008) or that were reviews of research that mentioned disability (i.e., Boon et al., 2007); reviews of practices (i.e., O'Keeffe & Medina, 2016; Thompson et al., 2003). This process resulted in 16 intervention studies describing results of students' experiences with disabilities in PBL instruction.

To supplement the search described above, I also searched the *Interdisciplinary Journal of Problem-Based Learning* with the terms "disability" and "disabilities". This search step added one additional article (for a total of 17) that examined use of PBL with students with disabilities (i.e., Belland et al., 2006). The reason this might not have shown up on previous searches for PBL instruction is that the title of the article describes the study as one about problem-based learning even though a careful reading of the paper indicates clearly that it examined a project-based learning instruction (see Larmer and Mergendoller's [2010] description of a project-based learning instruction).

Of the 17 articles that I found relating to studies for students with disabilities in PBL instruction from this search, further close reading showed that only ten directly observed or discussed students with disabilities as participants. I excluded the other seven that either examined teacher perceptions and experiences (e.g., Bargerhuff, 2013; Hovey & Ferguson, 2014); or were a description of the development of a curricular tool (e.g., Katsanos et al., 2012). I summarized key information about the studies in Table 2. I

examined these studies to determine what types of measures of academic outcomes researchers used, measures of non-academic progress, and finally, the types of qualitative methods researchers employed in their investigations of PBL instruction.

Table 2

Studies that Included Students with Disabilities in PBL Instruction

Authors	Number of Participants/ Identified disability	Age/ grade	Design	Measures	Results
Boon et al. (2005)	10 students; 8 w/ LD; 1 w/ID; 1 w/ ED	10th grade	Quasi-experimental pilot study	Social studies content knowledge pre-test/ post-test; later post-test; survey	Students in study had increase of content knowledge as measured by pre and posttests. On Survey students noted that they liked the social studies computer project work more than typical work in class. There was no disaggregation of academic success based on disability.
Belland et al. (2006)	17 students; 5 w/ LD; 2 w/ ED; 6 w/ Mild ID (IQ=70); 2 w/ mod ID (IQ=50); 3 w/ multi disabilities; 1 w/ severe ID (IQ=35) 3 teachers	Avg 11 yrs	Case study	Interviews of Health class students; Observations; Health class student presentations	Students were highly engaged in the PBL instruction unit of study on accessibility in the community. Students with less severe disabilities showed increased compassion for students with more severe disabilities and helped out students with greater needs than their own. Teachers perceived that students concentrated more than when working in typical curriculum. Students perceived that PBL instruction helped them in motivation, social skills, and technology (use of computers and software). Students perceived collaboration in the project positively. Teachers felt that they needed to change their teaching to attend to students who needed more guidance in the PBL instruction unit than typical teaching strategies.

Authors	Number of Participants/ Identified disability	Age/ grade	Design	Measures	Results
Carr & Jitenda (2000)	9 students; disabilities were not described beyond "Significant learning and emotional problems"	10th grade	(Case Study) qualitative	Interviews of students in service-learning class; observations in service-learning class	PBL instruction allowed students to connect new information with previously learned information; PBL instruction created an environment that supported "diversified interests" and helped each student make progress towards IEP goals. All 9 students completed a 5-paragraph essay on their topic (this was not typical in traditional curriculum). Students developed "confidence and autonomy" (p. 44).
De La Paz & Hernandez-Ramos (2013)	10 students; 8 w/ LD; 1 w/ ASD and 1 w/ADHD	8th grade	Mixed methods (Case Study)	Pretest/ posttest w/ comparison group; student interviews; social studies student work; and student journals	Increase in procedural knowledge of history inquiry as well as academic knowledge of history in students with disabilities. Knowledge gap present between students with disabilities and typical peers was smaller after PBL instruction based on pretest and posttest scores. Students were not fully aware of the historical context of their studies when asked to look at primary source documents and photos. Students enjoyed the PBL instruction unit of study. Students with disabilities were able to "contribute to group work with products that were in most ways similar to their peers without disabilities" (p. 11). PBL instruction helped students with disabilities perform similar to their non-disabled peers.
Ferretti et al. (2001)	28 students; 24 w/ LD; 1 w/ ID; 3 w/ ADD; 59 students w/o disabilities	5th grade	Mixed methods (Case study)	Social studies pretest/ posttest; observations; attitudes scale	Academic outcomes were positive for both students with and without disabilities. Students without disabilities learned more based on posttest results. Based on attitudes scale survey students without disabilities were found to have greater self-efficacy than the students with disabilities prior to the PBL intervention. Both groups gained self-efficacy after PBL instruction intervention.

Authors	Number of Participants/ Identified disability	Age/ grade	Design	Measures	Results
Filippatou, & Kaldi, 2010	24 students who struggle in school 3 with disabilities; 2 w/ mild ID IQ=75-80; 1 w/ dyslexia	4th grade	Case study	Science class knowledge test; student survey; Interviews	Based on attitudes survey students with disabilities liked group work, found experiential learning beneficial; based on pre/posttest students with disabilities increased content knowledge of sea animals; based on interview data 5 of 24 students noted that they took on a passive role in group work; all 24 students reported that they enjoyed the group work portion of the PBL instruction unit; students with prior experience with group work had more positive attitudes toward the PBL instruction work.
Guven & Duman, 2007	7 students with mild ID	6-7 yrs	Quasi Experimental	Career education pre/post test	Students with ID showed academic gains in knowledge of bakeries from the PBL unit implementation.
Massey & Burnard, 2006	3 students with social emotional and behavioral difficulties (SEBD)	5-8 yrs	Case study	Elective class observations Chart for student engagement	Behavior problems reduced during project time over long-term implementation. Children gained problem-solving abilities over long term implementation. Children gained autonomy through long term implementation.
Okolo & Ferretti, 1998	11 students with “mild” disabilities in an inclusive class	11-12 yrs	Case study	Social studies class observations	Students with disabilities gained content knowledge of Latin American civilizations. Increase in understanding of argumentation and settling of disagreements based on informal student interviews. Teachers need to establish routines to help structure project time for students with disabilities. Positive attitudes toward cooperative learning increased in students with disabilities.

Authors	Number of Participants/ Identified disability	Age/ grade	Design	Measures	Results
Summers & Dickinson, 2012	Unknown	9-11th grade	Quasi experimental with control group; qualitative triangulation	Social studies standardized test scores; Retention data	Students showed positive social studies achievement through all 4 years Students with disabilities in PBL instruction had no significant difference in grade-level retention than students in traditional instruction. Students with disabilities showed academic progress in higher grades (10th and 11th) but not in the 9th grade year.

Results

General findings from the ten research articles that described experiences of students with disabilities in PBL instruction documented positive effects on students' process skills (i.e., developing arguments; Okolo & Ferretti, 1998) as well as content knowledge. Over 116 students with disabilities were included in the studies. Much like the studies including typically developing students, the studies that reported students with disabilities as participants included students from kindergarten through high school, represented urban and rural schools, and were from multiple countries.

Participants in the ten studies were identified with disabilities that ranged from intellectual disability (ID), learning disabilities (LD), emotional and behavioral disabilities (EBD), and autism spectrum disorder (ASD). Five of the ten studies included a total of 20 students with ID (i.e., nine in Belland et al., 2006; one in Boon et al., 2005; one in Ferretti et al., 2001; two in Flippatou & Kaldi, 2010; and seven in Guven & Duman, 2007). Four studies included a total of 45 students identified with LD (i.e., five in Belland et al., 2006; eight in Boon et al., 2005; eight in De La Paz & Hernandez-Ramos, 2013; and 24 in Ferretti et al., 2001). One study included one participant with ASD (i.e., De La Paz & Hernandez-Ramos, 2013). Four studies included students with EBD (i.e., two in Belland et al., 2006; one in Boon, et al., 2005; nine in Carr & Jitenda, 2000; and three in Massey & Burnard, 2006). The remaining participants identified with disabilities included students with ADD (e.g., three in Ferretti et al., 2001) and ADHD (e.g., one in De La Paz & Hernandez-Ramos, 2013); one student with dyslexia (e.g., Flippatou & Kaldi, 2010); 11 students identified as having "mild disabilities" in Okolo and Ferretti (1998). Summers and Dickinson (2012) did not report specific disabilities beyond saying that a certain percentage of participants received

special education services (i.e., 13.3% of students were identified as having a disability in 9th grade; 11.1% in 10th grade; and 18.4% in 11th grade). Although this shows a variety of students with disabilities have been included in this smaller group of literature for PBL instruction, there is a need for more studies including students with disabilities, especially populations of students with more severe disabilities such as ID and ASD.

Measures of Academic Outcomes. Seven of the ten studies that described students with disabilities as participants in classrooms using PBL instruction discussed academic outcomes specifically in terms of content knowledge. Content knowledge in a variety of subjects was shown to increase on various measures across these seven studies. Boon et al. (2005), De La Paz and Hernandez-Ramos (2013), Okolo and Ferretti (1998), and Summers and Dickenson (2012) all reported increases in social studies content knowledge for students with disabilities when taught using PBL instruction. Summers and Dickenson (2012) used district standardized test scores to show that students attending a school using PBL instruction showed positive academic gains in social studies and career and college readiness when compared to their peers in a high school using traditional curricula. Results of academic measures are summarized as part of Table 2.

Positive academic findings were demonstrated in early elementary settings as well. In Filippatou and Kaldi's 2010 study young students increased their science content knowledge of sea animals based on pre and posttests. Guven and Duman (2007) showed elementary students with severe disabilities increased their content knowledge of bakeries through their PBL instruction unit.

Non-Academic Measures of Progress. Beyond content knowledge, the studies examining PBL instruction implemented with students with disabilities also demonstrated

academic process skill development. For example, Carr and Jitenda (2000) found that when students with disabilities were taught in a classroom using PBL instruction they were able not only to describe how their new learning connected to their previous learning, but also could complete a five paragraph essay, which had not happened previously in the class. Ferretti et al. (2001) described students increasing their self-efficacy after experiencing PBL instruction. Okolo and Ferretti (1998) reported that the students in their study of a classroom using PBL instruction increased their understanding of argumentation as a tool for discourse and learning. These studies show that students with disabilities in classrooms using PBL instruction are able to learn academic process skills along with their nondisabled peers.

Summers and Dickenson (2012) reported that students with disabilities' grade-level retention (i.e., the students staying in school) was positively impacted in the 10th and 11th grade years for students with disabilities. The results for the retention rates at the 9th grade year were no different than the comparison high school. This shows that students with disabilities in this PBL instruction stayed in school longer than their comparison group peers at a high school with a traditional curriculum and suggests that PBL instruction can be a promising tool in keeping students engaged in school.

Teachers in Belland et al.'s (2006) study reported that the PBL unit helped students with disabilities develop social skills and appropriate behavior. Teachers also reported that students were able to stay more engaged as measured by their on-task behavior. Massey and Burnard (2006) described that the students in a guided project developed autonomy in their learning based on teacher reports as they progressed through PBL instruction. The students with disabilities in classrooms using PBL instruction learned how to solve complex problems (i.e., how to find information to answer a question from multiple sources) and developed

strategies for dealing with specific problems (i.e., contradictory information) encountered through the inquiry process. The findings from Belland et al. (2006) and Massey and Burnard (2006) suggest that students with disabilities can benefit in both academic and social behaviors (i.e., on-task behavior and social skills) in classrooms structured with PBL instructional practices.

Ferretti and colleagues (2001) studied student and teacher perceptions of student learning in classrooms using PBL instruction. This study demonstrated that that fifth-grade students with mild disabilities in a PBL unit about westward expansion of the United States reported higher self-efficacy in engaging in the classroom after a PBL instruction unit of study, based on post-survey results. In a study of fourth grade students in cities in Greece, 24 students with learning difficulties were taught in a classroom using PBL instruction (Filippatou & Kaldi, 2010). Students' self-perceptions of their own learning, based on interview data and learning attitudes scale surveys, showed positive results. The authors also noted from interviews with students that, "all students stated that project-based learning helped them learn better" (p. 23). Belland et al. (2006) reported that students with disabilities and their teachers both valued the experiences they had in the PBL instruction unit of study.

Research Designs and Methods. Researchers in the ten studies that included students with disabilities in classrooms using PBL instruction used two main types of research methodologies for their studies. Seven of the studies used case study design and methods for understanding the experiences of students with disabilities in classrooms using PBL instruction, while three used quasi-experimental methods. The case studies used a mixture of interviews (e.g., Belland et. al., 2006; Carr & Jitenda, 2000; De La Paz & Hernandez Ramos, 2013; Filippatou & Kaldi, 2010); observations (e.g., Belland et. al., 2006;

Carr & Jitenda, 2000; Ferretti et al., 2001; Massey & Burnard, 2006; Okolo & Ferretti, 1998); surveys (Boon et al., 2005; Ferretti et al., 2001; Filippatou & Kaldi, 2010); and student work analysis (e.g., Belland et al., 2006; De La Paz & Hernandez-Ramos, 2013). These studies will help me shape my methods for my own study.

Potential Concerns for Students with Disabilities. Five of the ten studies I included in this literature review of the available research that included students with disabilities identified some possible concerns that students with disabilities might experience in classrooms using PBL instruction. In this section I will summarize the key concerns that authors speculated (i.e., described to frame their studies) and found (i.e., results of study) that apply to my current study.

PBL instruction offers unique challenges for students with disabilities. The studies described above offer insight into the challenges that they identified for their learners. For example, Flippatou and Kaldi (2010) speculated that students with disabilities might struggle with applying their learning to new contexts and using cognitive and metacognitive strategies for problem resolution or organization of their knowledge in PBL instruction. Guven and Duman (2007) speculated that students with disabilities might have difficulties differentiating from relevant and irrelevant ideas in their learning. Summers and Dickinson (2012) found that students might need significant time in classrooms using PBL instruction to see gains in academic knowledge and skills. Massey and Burnard (2006) found that promoting problem-solving skills and autonomy in students with disabilities was only accomplished with long term implementation of PBL instruction. Belland et al. (2006) found that teachers felt that they needed to attend to the needs of students with disabilities and give guidance preferentially to students with disabilities in order to promote academic knowledge and skill

acquisition during PBL instruction.

Based on these concerns brought up in the existing literature there are clear suggestions for teachers wanting to implement PBL instruction in their classroom. In order to address the need for students with disabilities to learn cognitive and metacognitive strategies teachers should deliberately teach and reinforce cognitive and metacognitive strategies to students with disabilities. This aligns with Swanson's (1999) recommendations for teaching students with specific learning disabilities (SLD). In Swanson's meta-analysis of research on strategies that promote learning for students with SLD, he found that a combination of direct instruction and strategy instruction promoted student learning. Of particular note is the strategy of modeling for students' instructional practices, providing prompts of learning strategies to use, and engaging students in process-type questions.

Two of the strategies Swanson (1999) reported that might address the concerns of students not differentiating important and irrelevant information would be that teachers break information and activities into smaller chunks and supply regular, quality feedback to students while they are learning. These two strategies might help teachers address gaps and misunderstandings in the students' learning and help students understand what is important to know and understand in the classwork in PBL instruction.

In order to address the concerns that Belland et al. (2006) found regarding the need for teachers to give more guidance to students with disabilities teachers could use existing research on effective instruction for students with SLD to utilize graphic organizers and other similar visual strategies to help students organize and process information. They might also provide regularly scheduled independent, well designed, intensive practice of the knowledge and skills that they are expected to learn in a classroom promote learning for students with

SLD (Swanson, 1999).

Conclusion

Students with disabilities have been greatly underrepresented in the literature that examines the effects of PBL instruction. Based on this literature review only ten studies directly addressed the experiences of this very important subgroup of students. Of the over twelve thousand students included in all of the studies in this review of the research, only a little over 100 students with disabilities were included.

Based on the minimal representation of students with disabilities in the literature describing the efficacy of PBL instruction with students, the most significant finding was that students with disabilities showed an increase in their retention rates at higher grade levels (Summers & Dickinson, 2012). This is extremely significant since Civic Enterprises and John Hopkins University (2015) reported that the graduation rate of students with disabilities in the United States lags by 20 percent when compared to the graduation rate of typically developing students. The promise of PBL instruction as a tool to address the disproportionate dropout rate for students with disabilities is very encouraging and should be explored further.

Based on the findings of the reviewed studies, that content knowledge of students with disabilities is positively affected by PBL instruction but they may need some additional, individualized instruction and support to maximize benefits. The extent to which this positive impact compared to the impacts on the learning of students without disabilities was significantly less. Studies that addressed content knowledge across a variety of settings and grade levels included in this research review showed positive results, but the overall impacts on achievement gaps preexisting in students with disabilities were not as powerful as in students without disabilities (see Ferretti et al., 2001). These findings refute researchers who

have criticized inquiry-based learning strategies (e.g., Kirschner et al., 2006). The authors described one criticism of inquiry instruction methods as the student needing more guidance during class than inquiry-based methods offer. They challenged constructivist educational methods because students need more support than the minimal guidance that these methods offer. The authors argue that the limitations of working memory of students is not attended to in inquiry methods of teaching. Of particular note in the criticisms of inquiry methods of teaching is the criticism of methods of instruction that mirror what a professional in the discipline does. Kirschner et al. (2006) gave the example of a science curriculum that mimics the activities of a professional scientist in the application of knowledge rather than a curriculum as a body of knowledge to be learned. This critique seems to contradict the entire nature of PBL instruction as well as constructionist ideals as outlined in Chapter One. Students construct their knowledge through their experiences and with the assistance of teachers through the process of their learning.

Component Analysis of PBL Instruction Components (Larmer & Mergendoller, 2010)

In order for me to understand the scope of what has been termed Project-based Learning in the research, I conducted an additional analysis of each study included in the research review for typically developing students and students with disabilities using the seven components of PBL instruction that were described in Chapter One. Culclasure et al. (2019) used a tool and a rubric for classroom observations of PBL instruction implementation fidelity, but a standardized tool does not exist for the measurement of implementation fidelity in existing studies. Because implementation fidelity was identified by some researchers as important for positive student outcomes (i.e., Capraro et al., 2016), my goal for the component analysis section of this study was to determine if researchers in

each reviewed study utilized all of the seven components in their PBL instruction interventions, and if not, then which components were most often implemented. To do this I first searched each individual study using key words from the seven components. Then, if I could not tell if the component was clearly implemented in the study using that key word search, I carefully reviewed the methods and results sections of each article to find mention of the components. A component was marked as present if the authors clearly stated that it was used in the intervention. If the component was only mentioned in the research review portion of the study, then I did not mark it as present. There are two studies, Feretti et al. (2001) and Summers and Dickinson (2012) that overlap from students with and students without disabilities so the total number of studies reviewed in the table is 41. The summary of this analysis is included in Table 3.

Table 3

Components of PBL Instruction (Larmer & Mergendoller, 2010) Included in Reviewed Studies

Authors	Need to Know	21st century Skills	Driving Question	Voice and Choice	Inquiry and Innovation	Feedback and Revision	Presenting to Public Audience
Apedoe et al. (2012)		xx			xx		xx
Beckett et al. (2016)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Belland et al. (2006)	xx	xx	xx		xx		xx
Boon et al. (2005)		xx			xx	xx	xx
Capraro et al. (2016)		xx	xx	xx	xx	xx	
Carr & Jitenda (2000)		xx		xx	xx	xx	xx

Authors	Need to Know	21st century Skills	Driving Question	Voice and Choice	Inquiry and Innovation	Feedback and Revision	Presenting to Public Audience
Chang & Lee (2010)		xx			xx	xx	xx
Chang & Tseng (2011)		xx				xx	xx
ChanLin (2008)	xx	xx		xx	xx	xx	xx
Cheng et al. (2008)		xx				xx	
Culclasure et al. (2019)	xx	xx			xx	xx	xx
Demirci (2010)		xx		xx	xx	xx	xx

Authors	Need to Know	21st century Skills	Driving Question	Voice and Choice	Inquiry and Innovation	Feedback and Revision	Presenting to Public Audience
De La Paz & Hernandez-Ramos (2013)		xx	xx		xx	xx	xx
Edmunds et al. (2017)		xx	xx	xx	xx	xx	xx
Erdogan et al. (2016)		xx		xx	xx	xx	xx
Ferretti et al. (2001)		xx			xx	xx	xx
Filippatou & Kaldi (2010)		xx			xx		

Authors	Need to Know	21st century Skills	Driving Question	Voice and Choice	Inquiry and Innovation	Feedback and Revision	Presenting to Public Audience
Guven & Duman (2007)	xx	xx		xx	xx		xx
Han et al. (2016)		xx				xx	
Holmes & Hwang (2016)		xx			xx		
Hong et al. (2013)		xx			xx		
Hsu et al. (2015)		xx		xx		xx	xx

Authors	Need to Know	21st century Skills	Driving Question	Voice and Choice	Inquiry and Innovation	Feedback and Revision	Presenting to Public Audience
Hsu et al. (2016)		xx		xx	xx	xx	xx
Hugerat (2016)	xx	xx	xx	xx	xx	xx	xx
Kaldi et al. (2011)		xx			xx	xx	
Kalyoncu, et al. (2010)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Lee & Tsai (2004)	xx	xx	xx	xx		xx	xx

Authors	Need to Know	21st century Skills	Driving Question	Voice and Choice	Inquiry and Innovation	Feedback and Revision	Presenting to Public Audience
Lou et al. (2014)		xx		xx	xx	xx	xx
Lu & Law (2012)		xx		xx	xx	xx	xx
Massey & Burnard (2006)	xx			xx	xx	xx	
Morales et al. (2013)		xx		xx	xx		xx
Okolo & Ferretti (1998)			xx	xx			xx

Authors	Need to Know	21st century Skills	Driving Question	Voice and Choice	Inquiry and Innovation	Feedback and Revision	Presenting to Public Audience
Ozdener & Ozcoban (2004)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Petrucco (2013)		xx	xx		xx	xx	xx
Seet & Quek (2010)		xx	xx	xx	xx	xx	xx
Smith (2016)		xx		xx	xx	xx	
Summers & Dickinson (2012)	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear

Authors	Need to Know	21st century Skills	Driving Question	Voice and Choice	Inquiry and Innovation	Feedback and Revision	Presenting to Public Audience
Tsai et al. (2015)	xx	xx		xx	xx		
Wang et al. (2016)		xx					
Wuttisela et al. (2016)		xx	xx (Hypothesis)	xx	xx	xx	xx
Zusevics & Johnson (2014)		xx				xx	

Findings from Component Analysis

My analysis revealed that the reporting of the implementation of PBL instruction across the reviewed studies was not consistent. Only one study (Hugerat, 2016) clearly described all seven components of PBL as defined by Larmer and Mergendoller (2010). Based on the review of the included studies ChanLin (2008), Edmunds et al. (2017), Lee and Tsai (2004), Seet and Quek (2016), and Wuttisela et al. (2016) are the only five studies that implemented six of the seven components. Four studies included in this review (i.e., Beckett et al., 2016; Kalyoncu et al., 2010; Ozdener & Ozcoban, 2004; Summers & Dickinson, 2012) did not describe any of the seven components of PBL instruction. Further, two studies did not clearly describe the implementation of PBL instruction (e.g., how teachers were trained, what constituted PBL instruction practices, implementation fidelity checks) at their schools (Kalyoncu et al., 2010; Summers & Dickinson, 2012). This is important because it highlights a lack of clarity about how PBL instruction should be implemented. Even though implementation fidelity has been described as being impactful on the academic performance of students, not all researchers have used all components in their studies. Also, the use of the term "project" might not accurately describe a PBL instruction experience for students.

The modal value of components apparent in the 41 studies (two studies overlapped on the two lists) was 5. The PBL instruction component that appears to be omitted with the greatest frequency across studies is the "need to know," and the component found with the greatest frequency was "21st century skills" (i.e., including group work in the learning setting). The "need to know" component has been described as developing the reason why students need to learn about what they are studying in a given class as well as helping students generate a list of the information they need to learn to complete a project based on

that topic. The five studies that described six of the seven components of PBL omitted descriptions of a few different components. ChanLin (2008) and Wuttisela et al. (2016) did not describe the Driving Question, while Edmunds et al. (2017) and Seet and Quek (2016) did not describe the Need to Know and Lee and Tsai (2004) did not describe the Inquiry and Innovation. Almost half (19 out of 40) of the studies included in this component analysis had either five or four components clearly included in the study (i.e., 11 of the studies described five components, and eight studies that described four components). This component analysis points to a need for studies to accurately and concisely describe the conditions in which students experienced PBL instruction. This will help future researchers and practitioners understand the scope and complexity of doing more than just a "project" in their classrooms.

While the scope of research that included students with disabilities is limited, the fidelity of implementation has been noted as an important factor for successful outcomes. Based on this review of the literature for students with and without disabilities in classrooms using PBL instruction there is not a consensus, based on the literature that it is effective at promoting positive academic outcomes. This might prove to be a next step in the work that I hope to accomplish by understanding the effects of PBL instruction on the academic and social aspects of our students lives. This also serves as an indicator of the power of the research paper and how teacher pedagogy is transmitted to practitioners. If fidelity of implementation affects the efficacy of PBL instruction, then a clear description of the pedagogy and its implementation should be evident in the literature surrounding the topic.

Discussion of Component Analysis Findings

While this component analysis may not be the best or only indicator of quality of implementation of PBL instruction in the reviewed studies, it helped me understand how the

implementation of PBL instruction has been described in the literature. This is an important consideration for my research on PBL instruction since some studies have found that poor implementation fidelity of PBL instruction negatively affects student performance and outcomes (e.g., Capraro et al., 2016).

The overwhelming lack of description of the "need to know" component in the studies is especially concerning. As noted by the Gates Foundation study described in Chapter One (Bridgeland et al., 2006), there is a clear need to address the relevance of what students are learning in school to their own lives in order to keep them in school. The authors of this study reported that students dropped out because they did not feel that their learning was relevant to their lives. The "Need to Know" component, as described in Chapter One, is supposed to ground a PBL instruction study could be an important tool for students to use to develop and find meaning in what they are studying with their teachers. Indeed, Dewey (1933) and Kilpatrick (1929) suggested that students need to experience activities that have meaning associated with their lives (i.e., a "need to know") long before Larmer and Mergendoller (2010) or the Gates foundation study (Bridgeland et al., 2006) talked of its importance. It is concerning that this foundational component of not only PBL instruction, but the earliest iterations of purposeful education was not apparent in the literature reviewed.

The frequency of inclusion of group projects in the reviewed studies (i.e., "21st Century skills") seems to have been an issue that might have affected my literature review as a whole: PBL instruction, with essential components, might also be used to describe group project work in a class using more traditional instruction. While this might be seen as splitting hairs, the research has described that the essential components of PBL instruction and the fidelity of implementation of it has been implicated as essential to student success.

Therefore, in my study I will strive to describe the context of the classroom that I will study based on the seven components of PBL instruction as well as describing the historical work done by the teacher to understand the components of PBL instruction and how they are implemented in their classrooms. This will help future researchers and practitioners who choose to study and implement PBL to develop a project that adheres to the components that make this a pedagogy.

My analysis of the studies included in this review indicated that the definition of PBL instruction has both been loosely interpreted by researchers to fit a variety of settings and methods for teaching and may not adhere to the key components set forth in the literature that described PBL instruction in detail and its implementation has not been clearly communicated in the literature. Whatever the case might be for this lack of clarity in the literature, this is a point that needs to be clearly understood to further validate and support the findings that PBL instruction is a valid instructional method to support academic and social learning for all students.

Conclusion

Findings within the studies I reviewed showed general support for PBL instruction to support student learning both for typically developing students and students with disabilities. Two primary implications for teachers who choose to implement PBL instruction in their classrooms can be drawn from this review. First, PBL instruction needs to be implemented fully, with attention to the seven components as a whole, in order to facilitate greater student growth. Second, teachers need to attend to the specialized needs of the students when using it (i.e., students collaborating with other students, and managing time and group tasks) in order for students to experience maximum success.

Questions still remain, however, about what aspects of PBL instruction support learning for students with disabilities. In particular, fidelity of implementation for PBL instruction in classrooms was emphasized in reviewed studies, but the details of the implementation of PBL instruction was not always clear in the studies included in this review. For example, not all studies seemed to include all components of PBL instruction and detail on how each component was implemented were lacking. Since there has not been a clear understanding of how to ensure that PBL instruction was implemented fully in any study, I needed to make certain that people who will read my study in the future know exactly the detailed context of how PBL instruction was implemented through this study. This included documenting the elements of PBL instruction present in the site I studied and how teachers and students implemented and used the components.

Relatedly, teacher support of students in PBL instruction was discussed in the reviewed studies but at times the details of this support were not clear. Lack of clarity in how teachers support students with disabilities in PBL instruction shaped the focus of my study. I included noting how students with disabilities' interactions with teachers and peers, instructional activities, materials, and tools supported their learning.

Teacher and student perceptions of success in PBL instruction, both academic and social, appeared to be important based on this reviewed literature. Since there is little research that focused on students with disabilities in the available research, I explored how this subset of learners experience a pedagogy that has been nebulous in implementation as well as definition for most of its history.

Chapter Three

Method

In order to study the complex phenomena of the experiences of a student with a disability in project-based learning (PBL) instruction, I took my understanding of the underpinnings of PBL instruction and the principles of special education outlined in Chapters One and Two and developed a study to describe the experiences of a student with a disability in a classroom using PBL instruction. I chose to study a student at the school in which I taught since the school used PBL instruction in each class. In this chapter I describe the theoretical framework for this study and the methods for data collection and for data analysis.

Theoretical Framework

As outlined in Chapter One, PBL instruction is based in the theoretical framework of constructionism, which extends the theory of constructivism (Kafai & Resnick, 1996). Constructivism shaped the method and analysis of this study. In particular I was interested in how students learn project academic content and skills through interactions with others related to the project materials (e.g., handouts and documents for collaborative projects), purposeful activities/acts (e.g., making something meaningful and connected to project content), and interactions with teachers, peers, or others.

By studying this I hoped to further understand how the following theoretical notions apply to student with disabilities: Vygotsky and Luria's (1994) ideas of how children use tools promote learning; Kilpatrick's (1929) ideas of purposeful acts as a means of learning; and Papert's (1993) ideas about learning through interaction while making something. I chose a case study design to explore the main question of my research study: How do students with disabilities experience PBL instruction in relation to their supports and

interactions with instructional activities, materials and tools, and instructors and fellow students? This question was further developed through each of these following questions:

1. What components of PBL instruction are present in the classroom and how does the learning environment scaffold learning for students with disabilities in PBL instruction?
2. How do students navigate learning in PBL instruction (i.e., what are students doing when they interact with learning materials and activities and how are they interacting with teachers and peers to learn project content and skills)?
3. How do students demonstrate their learning of a new content skill in PBL instruction?

Constructionism also drove my analysis of data collected in the case study. As I discussed in Chapter One Papert (1993) described how a child's culture, when it is rich in examples of the concepts and materials that make learning more simple and concrete, can help the learner pick up concepts early and spontaneously. Also, Vygotsky and Luria (1994) described how learning is promoted when "two-fold stimulus" occurs. Learners interacting with a curricular tool as well as interacting with a person while using the tool promotes higher psychological functioning. In order for me to learn about Vygotsky and Luria's two-fold stimulus as well as Papert's cultural learning I needed to not just rely on interviews or other methods of study. I needed to collect data that showed the multiple perspectives of how students with disabilities learn through interactions with curricular tools and others. To accomplish this, I interviewed a student with a disability and his teachers, conducted observations, recorded focal student interactions in class, reviewed curriculum documents, and recorded student and teachers' artifacts from the project class. Thematic analysis allowed

me to then describe the experiences of a student with a disability in a classroom that uses entirely PBL instruction.

In constructionism, learners "actively construct and reconstruct their knowledge out of the experiences in the world" (Kafai, & Resnick, 1996, p. 2). As a researcher, this framework helped me understand the experiences of a learner with a disability in the classroom as he actively constructed knowledge through PBL instruction. I was actively looking for the construction and reconstruction of knowledge through the experiences of the learner and the interactions of the learner in the classroom. I also was interested in improving my own practice since I was a teacher in a school using PBL instruction so I was invested in this method of teaching, and the process of learning about the experiences of students with disabilities in PBL instruction held the potential to help me better practice PBL instruction and inform the field in an area where there are few studies that have included students with disabilities.

Design

As outlined by Yin (2013), case study helped me construct my understanding of the phenomena of the experience of students with disabilities in a PBL instruction. Yin described case study as an iterative process that is used to describe a complex setting or set of questions while retaining a holistic and real-world perspective. The iterative process of case study fits well within the realm of sociocultural constructivism. Vygotsky and Luria (1994) discussed how action precedes word and then words themselves become action. Sociocultural ideas like the transformation of action to word, to word as action is created through the interaction of people. Humans negotiate meaning of language through the interaction of culture, context, and action. This then translates into words becoming the action. Case study connected to

these ideas because it allowed me to observe and understand the interactions in the classroom that built the learner's knowledge in the typical setting of PBL instruction without intervention. It also allowed me to capture multiple aspects of the learning environment through interview, observation, artefacts, audio recording, and curricular documents without being a participant in the classroom beyond a research capacity.

Case study fit as a method to answer my research questions. Yin conceptualized case study as having the potential, through the *common case* rationale, to capture what happens in everyday situations because these might help to understand social processes connected to a theoretical interest. For this study I was interested in how the social negotiation of learning creates acts of learning and then how those acts of learning become acts of knowledge themselves.

Yin (2013) characterized case study as using similar techniques that historians use to describe an event or place in time through the use of direct observation of events coupled with interviews. Vygotsky and Luria (1994) described how speech and practical operations, through which learning happens, are rooted in the individual's learning history (i.e., their experiences in school in the past) and the individual's social environment (i.e., their life outside school). These two intersect because the phenomena that I studied -the experience of a student with a disability in a PBL classroom- represented the culmination of the individual history of the learner and the social environment of a learner. The power of this intersection can be obtained through interview and contextualized through observations with artifacts. The contextualization of the learning history of the student in the PBL instruction helped me understand Vygotsky and Luria's conceptualization of the progression of learning through the use of tools in social interactions

While studying the students in a classroom that used PBL instruction, I focused on small group behavior and academic performance just as Yin suggested. Further justification for my use of case study came from existing studies of PBL for students with disabilities that have used case study as well (e.g., Ferretti et al., 2001; Filippatou & Kaldi, 2010; Liu & Hsaio, 2002). Since the student within the project-based instruction that I studied was in a complex setting, I felt that case study would help highlight the experiences of students with disabilities experiencing this instruction. For example, students in classrooms that use PBL instruction usually work in collaborative groups using the curricular tools given to them by the teachers to solve a complex problem and address a driving question. The tools given to the students are used to accomplish a large task or solve a problem like building a concrete canoe to test how to make lightweight concrete that floats and is strong, or designing an enclosure so that animals and people are safe, while ensuring people have a positive experience when visiting a zoo.

Also outlined in Chapter One, there is conflicting evidence that supports and refutes PBL instruction as an effective instructional method for learning for students with disabilities. Since the evidence is not yet consistent as to the efficacy of the practice with students with disabilities, I concluded that a single case study would help add to the understanding of this instructional practice. Yin (2013) suggested that the use of single case study is warranted when there is a case that might be critical to existing theory or understanding and can help build knowledge and theory by "confirming, challenging, or extending the theory" (p. 40) and is the "preferred strategy when how or why questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context" (p. 1). A case study design was a

good fit for my proposed study because the study took place within an existing classroom through the course of one twelve-week project where I could not manipulate the events that happened. I focused my study on the experience of a student with disabilities in a classroom using PBL instruction and how he interacted with teachers, students, and the materials of the project in order to learn project content and skills.

Setting

The setting for my study was Henry High School (HHS), a small charter high school in an urban southwestern city. The population of Henry at the time of the study was roughly 400 students divided into two programs, the day school, which was my area of focus, and the night reengagement school. The day school students were similar to typical high school students in age (e.g., 14-18 years old), while the night school students were adults who have not received their diploma due to a variety of reasons ranging from family problems that required the students to find work to help out with bills, to minimal success in typical curricula of pen and paper-based instruction and assessment.

The school population predominantly identified as Hispanic (i.e., 95%) and 70% male. On average, students who attended Henry High School during the time of the study had deficits in their academic skills and high school transcripts when they came to the school. During the time of this study when students entered the school, they typically tested below grade level in math and reading, based on short-cycle and standardized assessment data from their previous school placement. Roughly 40 students with disabilities attended Henry High during this time with the majority of individualized education plan (IEP) eligibilities being specific learning disabilities (SLD) in reading and math. A few of the students with IEPs had eligibilities of emotional and behavioral disturbance as well as Other Health Impairments that

ranged from Tourette's syndrome to attention deficit hyperactivity disorder (ADHD); some students had autism spectrum disorder (ASD). During the study, when students arrived to Henry High, they were placed with an advisor who worked with them throughout their time in the school. The advisory teacher served as a guidance counselor, mentor, and primary connection to the school for the student and their family.

During my data collection there were fourteen teachers in the day program at the school of study. Teachers typically held multiple certifications. Of these teachers, seven had certifications in special education. There were three teachers certified in English, three in math, three in science, one in career and technical education, four in social studies, two in Spanish, and one in art. The three teacher participants in the study held certifications in the following areas respectively: special education science and English; special education math; general education Spanish and career and technical education.

PBL Instruction in Projects

The entire pedagogy of HHS was based in PBL as described by Larmer and Mergendoller (2010). The students learned academic content through projects instead of discrete content classes. Student learning happened through interdisciplinary project work where learners explored a topic and answered an essential question using required academic skills in many different disciplines. For example, in the project "Set in Stone," students explored the essential question: "You can do WHAT with concrete?" The students created different mixes of concrete to develop a floating concrete and ultimately built a concrete canoe. Students collaborated with local concrete test labs to obtain professional testing certification and were in charge of creating tests for their concrete to find its strength and density over the curing time. This project required students to learn skills in math, science,

woodshop, fabrication lab, and English. Students developed and implemented testing procedures for strength tests on concrete, calculated the results from the tests, estimated the amount of materials and created a budget for the large canoe build. Then they created and assembled the frame for the canoe and layered it with concrete. Afterwards, the students presented their findings in a written report and a presentation to community members including engineers and concrete testing professionals.

The HHS students had the ability to choose the project they wanted to work on for twelve weeks, much like university students choose their classes, but on a smaller scale. On the first day of class for the trimester, the students met with their advisory teacher and discussed the projects offered. The students then chose a project based on the credits offered in the class (e.g., math, physics, and chemistry for "Set in Stone"), the topic of the class, as well as many other factors that might have also played into their decision. The other factors may have included student interest in the topic, and even a student's relationship with a project teacher. This project cycle repeats three times at the beginning of each of three semesters of projects. The projects lasted approximately twelve weeks and the year-round school year lasted from mid-August to the end of June.

During the time of the study two to three teachers collaboratively taught each project. The projects were capped at 24 students per teacher, but teachers identified as resource teachers serving in a special education role did not add to the number of students in a class. This arrangement meant that there could have been as few as 24 students in a project with two teachers, or as many as 48 students with three teachers. Most of the projects offered at HHS had at least one special education teacher assigned to them, which explains the example above, but it was not always the case. The development and the focus of the project were

dictated by which teachers were connected to a project and their content expertise. For example, the "Set in Stone" project had one special education teacher and one general education teacher who both were certified in math and science.

In this setting teachers co-created lessons based on the essential question for a project. Even though there usually were multiple teachers on a project, one teacher would typically take the lead in the development and implementation of a daily lesson while the other teacher collaborated to provide support in a project. For example, "Set in Stone," as with all of HHS projects, followed the workshop model for teaching (Bennett, 2007). When one teacher was the main teacher for the lesson, the other co-taught the 15 minute introduction to the class, and then they both split up to help different groups of students through the day's activities; these activities included a lab component for most of the two hours and twenty minutes of class and then a fifteen minute debrief in which students discussed with the teachers and each other the challenges of the day and planned for the work tomorrow.

In the PBL classrooms at HHS all teachers supported all of the students during the work time of the project. This included the implementation of modifications and accommodations for students with disabilities as well as monitoring and supporting students without IEPs. All teachers were responsible for assessment and grading of work in a project. The assessments included the artifacts produced for the class as well as the completion of the project task. There was also a summative demonstration where the students present an exhibition of artifacts that they have created through the project. The exhibition was attended not only by teachers and support staff of the school, but also industry professionals who helped teachers design projects based on their outside expertise. These presentations required the students address a thematic question about the learning. For example, the students in "Set

in Stone" were assessed on the building and testing of their individual concrete mixtures, their model canoe, the build and test of the large canoe as a group, and a scientific research paper that summed up all of their experiences in creating the canoe.

Mistakes in Architecture

The classroom project I chose to study for this case was "Mistakes in Architecture." I selected this project because the teachers assigned to this project met my inclusion criteria for teacher participants. This project was taught by three teachers: two special education teachers and one general education teacher. The lead teacher, "Beth," had taught at HHS for four years prior to the start of this study. "Ann", the second special education teacher, as well as "Sarah", the general education teacher both had taught at the school for one year prior to the study. There were 29 students in the class. Of these students there were eight students with special education needs, and seven students who were English language learners. The project consisted of mixed grade students from freshmen, sophomores, and juniors.

The purpose of the project was to have the students study the driving question: "How do design, communication, and execution impact the success of a commercial building?" The students studied content standards in English writing and the human impact on place in social studies through the lens of architectural mistakes in the design and construction process of building a building.

The class started by studying a near-miss catastrophe in mid-town Manhattan: the Citicorp building. The students were guided through a study of fatal design errors that only were discovered years after it was built and occupied. In order to complete the study, the students studied the Citicorp building as a group, learned how budget proposals and hiring choices for subcontractors were made in the industry, created a mind map for describing the

Citicorp mistake, and answered the driving question in a small presentation based on their work in the first half of the class in order to prepare to develop their own case study on a separate building. The students presented their work on the second case study in the exhibition at the end of the project.

Participants

I recruited one student with a disability, three teachers, and one collaborating peer as participants. I had planned to recruit multiple students but did not have the response rate anticipated. In the sections below I describe recruitment procedures and participants.

Student Participant

In order to recruit the student participant for this study I asked teachers in "Mistakes in Architecture" to identify all students on the class roster who had special education needs. Then the teachers reported the preliminary list of potential participants to a school leader (i.e., director of student support) and, since these students were under the age of 18, I asked the director of student support for permission to contact families to describe the study and ask consent from students' guardians. One student and his family indicated interest in the project. I set an appointment with a school social worker and parents and the student together to describe the study, answer questions, and explain the rights of participants. I described to the potential participant and his family that participation was completely voluntary, and I reassured parents that I was not involved in the assessment or evaluation of their student in the project. I also explained that I would not be grading the participant in my other classes. I described that in the event that the participant dropped out of the study, that his grades would not be affected by that decision. After explaining the study and answering any questions the family or the participant had, I left the room and the social worker gave the participant and

his family the consent/assent forms. The social worker asked that the parents and participant to return the consent and assent forms to her within five days if they decided to participate. Consent and assent were received from one student and his parent in the project.

The focal student for this study met the following criteria to be invited to participate as a focal student: (a) he was enrolled in the selected project; (b) he had been enrolled at the school for at least one trimester at HHS with an attendance record showing no more than six absences for the most recent trimester; (c) he had an identified disability; (d) he had a current IEP with goals and modifications/accommodations; (e) he gave assent to participate in study; and (f) since the focal participant was under 18 years old, the participant's parent/guardian gave consent for the participant to participate in study.

For the purposes of this study I assigned the focal student a pseudonym of "James." At the time of the study he was 16 years old, identified as a Hispanic male, and had special education eligibility in the areas of specific learning disability for reading. He had attended the school for one year and eight months at the start of the study. This student was enrolled in a project called "Mistakes in Architecture," a project that assessed English and social studies standards through studying the driving question "How do design, communication, and execution impact the success of a commercial building?"

Based on his current IEP, James' post-high school goals were to learn and enter the construction trades as an electrician. His current assessments for language arts had him at beginning steps for reading comprehension and expressive language, but functional assessment by teachers showed him able to identify the central idea of a text in 60% of the instances in his classroom performance. His goal for reading on his current IEP was to improve his ability to identify the central idea of a text from 60% to 80% proficiency within

class.

Teacher Participants

In order for teachers to have been included in the study, they had to have worked in a school like the current one that used PBL instruction in classrooms for at least one year prior to the study. Similarly to student recruitment, I set a joint appointment with a school social worker and potential teacher participants on the project to discuss the study. I described the study, answered questions, and described the rights of the participants. I then stepped out of the room so the social worker could give them the consent form and answer any other questions about the study. The social worker asked that the teachers return the signed consent form to her within five days indicating whether or not they want to participate.

I recruited three teacher participants using this method. Teacher Ann was a special education and general education-licensed teacher with one year of experience teaching at HHS who identified as a white female. Teacher Beth was a special education and general education licensed teacher with four years of experience teaching at HHS who identified as a white female, and Teacher Sarah was a general education licensed teacher with one year of experience teaching at HHS who identified as a Hispanic female. Sarah was on an alternative pathway for her teacher license.

Collaborating Peer Participant

After recruiting and consenting the focal student and teachers, I also recruited James' collaborating peer (assigned the pseudonym Eli) to participate in the study using the same process. Eli was a junior at the time of the study and had no identified disability and identified as a Hispanic male. Eli had known James for one year at the time of the study and worked consistently with James in his classes. Collaborating peer was defined as a student

with whom the focal student completed his project work (i.e., they sat at the same table and worked together on collaborative learning tasks).

Timeline

The project class at the center of this study was set in the spring trimester of the school year. Participant recruitment started in March, and I collected data through June of the same year. The scope of the study followed the project through its entire 12 weeks, from the first day of project to the final, summative demonstration of learning for the project (i.e., exhibition). There were four projects concurrently running at HHS at the time of this study. See Table 4 for a description of the study timeline.

Table 4

Timeline of Procedures

Activity	Task	Timeline
Submit IRB Proposal//Obtain IRB approval	1) Obtain approval from site 2) Complete and submit University IRB	February 2019
Recruit Participants	1) Explain study to principal, student support director, and project teachers as well as at least six potential focal students 2) Meet with potential participants and families to discuss study 3) Obtain consent and assent from participants and guardians	March 2019
Conduct Initial interviews	1) schedule interviews 2) Interview teachers 3) interview focal student	April 1 – April 15
Conduct observations/audio recordings in project class	1) Each Monday and Thursday I sat in class and completed electronic observation field notes for two hours and 20 minutes 2) Audio recordings in class for focal student interactions	April 10 – June 28
Collect student/teacher artifacts and record final exhibition	1) Collect digital images of work samples	April 10 – June 28
Conduct Final Interviews	1) schedule interviews 2) Interview teachers 3) interview focal student	June 24-26
Transcribe audio of interviews and audio recordings	1) Transcribe audio recordings 2) Transcribe interviews	June 1 – August 1
Upload data into Dedoose and conduct thematic analysis	1) Upload transcripts 2) Upload artifacts 3) Upload curriculum documents	June 1 – March 1

Data Sources

Case study methods require multiple sources of data to help understand complex phenomena (Yin, 2013). In the current study I employed five main data sources to answer the research questions. These included observations, audio recordings of teacher/student and student/student interactions, interviews, targeted questioning, curriculum documents, and artifacts. I selected these sources of data because I was interested in student perspectives as well as teacher perspectives of the experiences of students with disabilities in classrooms that use PBL instruction. Yin (2013) suggested that a single case study can work to challenge existing theories of a phenomenon. As discussed earlier, there are multiple studies that challenge as well as support inquiry-based learning strategies like PBL instruction as an effective tool for instructing students with disabilities. I wanted to make sure that I understood what was said and done in the classroom, so I needed the various sources of data to help me contextualize the interactions in the classroom to better understand in the phenomenon under study.

Observations

I conducted participant observations in the PBL classroom throughout project class time, observing while maintaining some interaction with students as outlined by Glesne (2016). I directly observed the classroom for a total of 16 days for at least two hours for each observation for a total of 36 hours over the last eight weeks of the twelve-week "Mistakes in Architecture" project. During these observation periods I also audio recorded during the class using a wireless microphone placed in a container on the table near the focal student. The audio recorder was connected to a mixer that could change the audio levels for the microphone. This allowed me to target specific conversations based on what appeared to be

happening in the class and turn off the microphone remotely if needed.

Direct observations focused on the experiences of James in the class as he interacted with peers, teachers, and curricular materials. In addition to the audio recordings and direct observations, I kept a digital field journal throughout the project. In this journal I recorded field notes describing interactions among students and between students and teachers during the project time while I was in the classroom.

I planned on using the observation tool included in Appendix D to help guide my direct observations. The purpose of the tool was to describe the physical environment and note where the focal students were located as well as the location of the audio recording device, and note which components of PBL instruction were found in the daily lesson and my evidence for them (e.g., the teacher verbally reminded the students of the driving question at the beginning of the class session). The tool was created to also help me log the interactions between focal students and others in order to see who is initiating interactions and content of the interactions in order to analyze how the content might help answer research questions. Ultimately, I found it more efficient not to use this tool and instead included this information in my digital field journal instead of on a separate form. I directly observed the class in session a total of 16 days over eight weeks leading up to the final exhibition.

Audio Recordings

During my direct observations I set up my observation station in the corner of the project room, next to my audio recording equipment. This helped me remove myself from my role as a teacher. On days when I directly observed the class I audio recorded using a wireless microphone as described above on the table within the project space where James was seated. To protect the privacy of James and others in the classroom I muted the audio

recording when James was not directly engaging in work, interacting with other students, or listening to instructions from the teachers. I included 18 audio recordings of classroom interactions in the analysis.

These audio recordings augmented my 36 hours of direct observations to help me understand what happened in class. This allowed me to be unobtrusive in the class and emphasize my role as a researcher with the students instead of as a teacher in the school. In the event that students asked me for help, I gently reminded them that I was not a teacher right now, and if they want to talk to me, they could connect with me after class.

I also audio recorded the exhibition of James' work at the end of the project. This recording was analyzed for evidence of how students learned new skills through interactions with teachers, students, and the work they did in class. I included the exhibition transcripts and student work leading up to the exhibition in the PBL instruction component analysis and thematic analysis. I had a graduate student transcribe these audio recordings, and I then uploaded them into Dedoose qualitative software for analysis.

Interviews

I conducted two semi-structured individual face-to-face interviews with the focal student and the three participating teachers. Merriam (2009) suggested using interviews "when we cannot observe behavior, feelings, or how people interpret the world around them" as well as "when we are interested in past events that are impossible to replicate" (p. 88). Examples of the questions I used included asking students and teachers to compare traditional class instruction to PBL instruction. I also asked teachers to talk about how supports were offered in the classroom and how they could tell if a student needed help with a classroom assignment. These questions would be difficult to observe directly in a class setting;

interviewing provided a way to investigate these more deeply. The list of interview questions is included in Appendices B and C. I audio recorded all interviews and then a doctoral student in linguistics transcribed the audio files into Microsoft Word documents. Merriam (2009) suggested that verbatim transcription be used in interviews because it provides more context for the interview than summary types of transcription. Naturalized transcription allows for speech to be translated into writing representing pauses and complete thoughts through grammar and punctuation (Davidson, 2009). The translation into a written form of what was said helps the transcript become accessible to the reader removed from the context of the recording (Davidson, 2009). Since I was interested in interactions between students and their peers, students and their teachers, and students and the work that they did in class, naturalized verbatim transcription allowed me to describe these interactions. The doctoral student who transcribed the audio for the study used verbatim transcription noting different participants with numbers and completely transcribing utterances and errors in speech while using punctuation to develop linguistic understanding for the reader. She used the transcription key found in Appendix E. The key ensured that she captured the meaning and context of the conversations with the participants as carefully as possible (e.g., pauses, intonations, and emphasis) and that these were accurately represented. I listened to the audio files while reading the Word documents and corrected any interpretations of what was said from my perspective based on audio files and my memory of the event based on my understanding of the context of the event. I then uploaded the corrected transcripts to Dedoose. I included eight interviews (i.e., four initial and four final) for analysis.

I conducted the initial set of interviews within the first two weeks of the project. This first round focused on an overview of the project from both the perspective of the teachers

and the student: what was engaging, easy, and difficult for students experiencing PBL instruction; and what they hoped that they personally, or their students, in the case of the teachers, might gain from this project.

The final set of interviews was conducted within two days after the project was completed. These readdressed the questions from the first interview and asked participants to reflect upon how their experiences compared to what they were expecting at the beginning of the project as well as describing the overall experience of the class.

The interviews were conducted during time not allotted for instruction during the school day (i.e., advisory time) in a student conference room on the school site to make sure that the participants were not unduly burdened with transportation and time considerations as a part of this study. I did not want to conduct these interviews during project class time since the students and teacher might consider this an intrusion to their work time and the intrusion might adversely affect the academic success of the students and the availability of the teachers to instruct. The interview questions for initial and final interviews have been included in Appendices B and C.

Targeted Questioning

I audio recorded conversations with James about interactions that he had during the project at the end of a daily project period. In these short, informal conversations I asked James more about how he learned project content or a skill that was observed in my observation notes or questions about his interactions with teacher or other students. These targeted interviews were short, (e.g., no longer than 5 minutes) and focused directly on what the students did that day in the project. For example, in one quick questioning event I asked James about the value of practice exhibitions and he described how he felt that they heled

him get ready for his final. I included the six transcripts of targeted questioning events for analysis.

Curriculum Documents

I also analyzed the curriculum documents associated with the project class. These included plans for teaching project content and summative archival documents for the project which were archival documents created by teachers at the end of the project to capture the experiences of the students in the project. I searched these for evidence of how their plan for the project and the experiences in the project helped support student learning. I also looked for evidence of how teachers addressed the needs of students with disabilities (e.g., teacher feedback, accommodation of curriculum, modification of assignments). I coded these documents as part of the PBL component analysis described later in this chapter.

Student Artifacts

I analyzed the student participant's work that was assigned to him for the project. I archived digital copies of written, graphic, and oral work. I looked for evidence of the learning that happened in the project based on teacher-defined learning outcomes (e.g., standards addressed) in the analysis of artifacts. I also coded these student artifacts as part of the PBL instruction component analysis.

Data Analysis

Since Yin (2013) emphasized the importance of multiple means of representation in a case study, I created an understanding of the phenomena of the experiences of students with disabilities in PBL instruction through observing in the class, using targeted questioning, and conducting individual interviews with students and teachers, along with analyzing curriculum documents and student artifacts in order to answer the questions for the study. I used memos,

categorizing strategies, and connecting strategies as outlined by Yin to make sense of the data.

In order to understand the experiences of a student with disabilities experiencing PBL instruction I established that the classroom used PBL instruction through a component analysis looking through the data sources for evidence of the seven components of PBL instruction. This was an important step to establish that the classroom was different than a typical secondary content-based classroom focusing on one curricular area (i.e., math or English). Based on my analysis of research examining PBL instruction in Chapter Two not all of the researchers studying PBL instruction reported evidence of the components in the settings they studied.

I conducted a thematic analysis of the data from observations, audio recordings of James and teachers in class, interviews, targeted questioning, student artifacts, and curriculum documents to answer the research questions outlined at the beginning of the chapter.

Development of Descriptors in Dedoose

After uploading data into Dedoose, to assist in analysis, I linked each piece of data with a descriptor. Each data piece had one descriptor for the type of data and type of participant. Data were broken down into five types. Observation data were observation notes from my digital field journal of what was happening in the class during my direct, in-class observations. Audio recording data were the transcriptions of audio collected during in-class observation time when James or Eli were interacting with either the teacher or each other. Interview data were the transcribed audio recordings of the initial and final interviews for teachers and the focal student. Targeted questioning data were the transcribed audio

recordings of the short (i.e., less than 5 minute) question sessions with James at the end of class time. Teacher and student artifact data were the teacher and student documents (i.e., planning documents, graphic organizers, worksheets) as well as summative archival documents (i.e., the construction document).

Component Analysis

I wanted to determine if this project was actually using PBL instruction as defined by Larmer and Mergendoller (2010). I created descriptive codes in Dedoose for the seven components of PBL instruction that I discussed in Chapters One and Two to determine if and where the seven components of PBL instruction were evidenced in the data. I examined all data sources and applied these codes as appropriate. In order to do complete this task, I first operationalized the components based on the definitions I provided in Chapter One that then became specific codes. This helped me understand what I was looking for when I was conducting the analysis. I looked at data type compared to these codes in order to establish that the components of PBL instruction were present in multiple aspects of the class in order to address some of my concerns from Chapter Two that the existing research I reviewed did not consistently and clearly describe the setting of the study, yet claimed it was PBL instruction.

The *need to know* is the component that helps students and teachers understand the "why" behind the project. I looked at the data for evidence that teachers and students engaged in conversations that answered why they were studying the project content. For example, I looked for teachers' use of the words "need to know" and how these were incorporated into the framework for the project in the documents that they used to plan their project. In interviews, I looked for teachers' and students' descriptions of why the project

was meaningful to them. This "need to know" should have been present in the beginning of the project to help students understand not only the large-scale learning goals for the project, but also in the daily instruction and student work of the project and possibly at the end of the project when students were exhibiting their work.

Another component of PBL instruction is described as *21st Century Skills* and includes these skills: creativity, innovation, critical thinking, and problem solving as well as communication and collaboration (Partnership for 21st Century Learning, 2008). I looked for evidence that students discussed how they divided up tasks to get group work completed, their process for figuring out how to complete a difficult task, their ability to communicate their needs to each other as well as to their instructors, and their process for answering challenging questions in the scope of their work. These 21st Century skills also include participating in a task that required students to work together and create a unique solution to a problem that was posed in the scope of the project work. Students talking to each other about topics not related to their project work did not count as communication. Likewise, students who shared non-content related information was not counted as collaboration.

The *driving question* for a project, another of the seven components, should have been evident in the project materials that were given to the students as well as the discussions between teachers and students throughout the entire 12 weeks of the project. I looked for a large-scale question identified as the driving question by the teachers that was revisited often in the class discussions and class assignments that encompassed the entire scope of the project work. This question should not have been a simple question to answer, but a question that could be answered in many different ways and required an in-depth study. This question should have been present through the final stages of students demonstrating their learning at

the final exhibition. When the teachers posed simple yes or no questions to the students that were not about answering a question about the central theme of the class, that did not count.

Student voice and choice was evident if the teachers allowed students options in how they not only studied their content, but how they presented their final understanding of the project content. The components of voice and choice are similar to differentiation as described earlier in Chapter One, so my attention to techniques of differentiation helped me understand if student voice and choice was apparent in the project. Some examples included students given options in what they studied to answer a question for the class or given options in how they completed daily work; students given multiple ways to access information in the classroom; and finally, students given multiple ways to show their learning. I did not count voice and choice when teachers gave choices that did not reflect individual *voice and choice* in the curriculum and the project work (e.g., teacher generated choices between two similar tasks).

I looked for *inquiry and innovation* as a component of the learning environment through attention to the following components: students generating their own questions and teachers guiding them through scientific and academic studies. This would have been present in the framing of the project at the beginning, and also needed to be present through the weekly assignments that the project teachers asked the students to do. I also looked for evidence of students pulling information from multiple sources and synthesizing it as evidence of in-depth inquiry. Students presenting what has been done by others before them to solve a project problem did not count as *inquiry and innovation*.

I defined *Feedback* as written or verbal comments from teachers to student about their performance on assignments. It was found as part of the teacher and student interactions

in the project or as written comments on a piece of work, a short conversation between teacher and student (one-on-one, or in group) that evaluated a component of their work. This happened throughout the project in many ways. Because feedback might not have just been in writing, audio recording as well as observation notes were imperative for my success in determining if these components were present. Students talking to each other about non-academic or skill-based tasks was not counted.

Lastly, the *presentation to a public audience* was present if the students discussed their driving question answer and showed their work to people other than their teacher in formative or summative demonstrations of learning. In these presentations (exhibitions) the students should have been discussing the steps that they took to answer the driving question, showed artifacts of their learning, and invited feedback from outside participants. Students presenting to and getting feedback from other students in the class was not counted as a *presentation to a public audience* unless part of a practice exhibition.

Thematic Analysis

I analyzed observation notes, transcripts of audio recordings, interviews, and targeted questioning, and teacher/student artifacts for the thematic analysis. I created brief notes following the observations that helped me remember what had happened that day. I hired a PhD student in linguistics to transcribe the interview data using verbatim transcription. I shared these files with her via password protected email attachments and when returned to me I then uploaded these initial interviews into Dedoose via their secure server (https://www.dedoose.com/about/security). As I collected audio recordings and targeted questionings, I also had those transcribed by the graduate student in linguistics who used verbatim transcription described above. In order to ensure accuracy, I read through the

verbatim transcriptions while listening to the audio recordings to correct any mistakes. As I collected images of artifacts and curriculum documents, I also uploaded those into Dedoose.

To start my analysis, I used a precoding process as suggested by Saldana (2016). I first read through the transcripts of the initial interviews looking for units of meaning. I highlighted teachers' and student's comments that struck me as relevant to the context of my research questions. These units of meaning became my first-round codes that I used to start the analysis. As I entered additional data into Dedoose I looked for similar units of meaning in these sources as the pre-codes that I established and started to finalize codes. I used what Saldana described as descriptive coding. "Descriptive coding summarizes in a word or short phrase -most often a noun- the basic topic of a passage of qualitative data" (Saldana, 2016, p. 102) The first codes that emerged in the data were "supporting students," "plan for connections," "PBL isn't just doing stuff," and "there's a point to instruction."

Once I developed my first round of codes, I returned to the data to conduct line-by-line coding (Saldana, 2016) through all data types until my codes reached saturation. I coded transcripts at the clause level and sections of documents. Excerpts could be assigned multiple codes. This involved completely rereading interview, audio, and targeted questioning transcripts and listening to audio recordings of all three as well as reviewing the artifacts and curriculum documents. I maintained a codebook using Microsoft Excel throughout the analysis. With each new round of coding I would start a new workbook to show the iterations of my codes. Originally my codebook only had the four listed above, but over the analysis I added to and refined the codes based on the data. After rereading the interview and audio transcripts, the observation field journal notes, and reviewing the artifacts and curriculum documents my advisor and I reviewed the codes I created and checked for overlap.

In order to develop larger categories of data (beyond the code level) I first looked for highest instance of excerpts. The highest instance of excerpts was “coach students through every moment” followed by “student tool use,” and “feedback” (all of these were child codes under the parent code of supporting students). I then looked at descriptor analytics using Dedoose to see the instances of parent and child codes individually through the multiple data sources (e.g., observations, audio recordings, interviews, targeted questioning, artifacts, and curriculum documents). I found that the codes and child codes represented across all data types more consistently than others occurred within child codes under “supporting students” (i.e., small group work, feedback, coach students). This became my first category of data. I have included the code tree for the thematic analysis as Appendix F.

I then printed out my code book, cut out each code and child code and gave them equal importance as I hand sorted the codes into categories of similarity based on my research questions. The hand sorting of paper slips of codes started with my initial category of “supporting students.” I fit each code and child code into this category if the definition applied to supporting students. Then I set aside the remaining codes and focused on the supporting students category. I looked for any similarities and differences within the subset of codes and created two subcategories. The two subcategories of indirect and direct supports emerged. Then, I examined the remaining codes and child codes to coalesce them into other categories. I then started realizing that there were overlaps, or connections that occurred that connected larger categories together. To address these, I created an operational model diagram (Glesne, 2016) to develop how the categories, as Glesne described, to visually represent the development of my analysis. The intermediary codes developed connections that emerged as a web, so I used those interconnections to create a mind map out of the

operational model diagram. I then presented the initial categories and proto-themes to my colleagues in my doctoral program and described how they were connected through intermediate codes. Next, I created a map using mind map software in order to visually represent my categorical analysis. After discussing this with my advisor I decided that these larger categories represented significant themes in the data. From the categorical analysis I developed and defined four themes. These themes included: (a) Supporting students; (b) student buy-in; (c) teacher and student interaction in PBL is complex; and (d) student demonstration of learning.

Trustworthiness

In this section I describe how I determined the trustworthiness of my study. Merriam (2009) argued that "every researcher wants to contribute knowledge to the field that is believable and trustworthy" (p. 234). She also argued that the credibility of research is addressed through triangulation, member checking, being at the research site for an extended time, and asking peers to review emerging findings. I employed all of these with this study. In the next sections I will describe the three main components of trustworthiness that I used to strengthen my study: peer debriefing, member checking, and triangulation across data types.

Peer Debriefing

Brantlinger et al. (2005) suggested that peer debriefing helps researchers create credible qualitative studies. In order for me to check my own biases in the interpretation of data I had a colleague (i.e., a PBL expert) with experience in PBL and its implementation in schools and HHS help me in the capacity of peer debriefing when creating my categories and themes. Brantlinger et al. described *peer debriefing* as "having a colleague or someone

familiar with the phenomena being studied review and provide critical feedback on descriptions, analyses, and interpretations or a study's results (p. 201). When I started to develop categories from the data, I showed my peer debriefing colleague the emerging categories and supporting deidentified data, then solicited feedback on whether the categories directly connect to the data from her perspective. I also showed my peer debriefing colleague the final themes so she could give me feedback on whether the final themes were connected to the data.

Member Checking

I conducted member checking one time during the study in two ways. After the second round of coding, I presented the codes with their definitions to the teacher participants in the study (approximately three months after the conclusion of the study). Shortly afterwards I presented the teacher participants with the four themes by showing them the digital mind map to ask for any additional input. The three teacher participants gave positive feedback about the codes I shared with them. They also gave positive feedback on the themes I presented to them from the analysis and were excited to hear the final outcomes of my study.

Member checking happened as an individual, in-person meeting for the teacher participants at the school. I solicited feedback on my findings in progress (as described above) and asked if I needed to adjust anything. One aspect that Beth asked me to recheck was the presence of some of the PBL instruction component codes. For example, at the second member checking meeting I described the lack of codes present for the "Need to know" category in the components of PBL, and one of the teacher participants described where she thought this was found in the curriculum documents. I reanalyzed the documents

and found more evidence of this code. This served as a final solicitation for feedback from my participants regarding the categories and themes of the study.

Triangulation

To show triangulation across data types for both the component analysis and thematic analysis I created descriptors of the data sources to identify and categorize the data through the data type and participant type. I used Dedoose to conduct simple relative percent analysis of the PBL instruction components and for evidence of triangulation of codes across these descriptors.

By creating a rich understanding of the experiences of how students with disabilities were supported and successful in PBL instruction I hoped to answer the overarching research question of the study and subsequent sub questions. I believed that through an understanding of the experiences of students with disabilities in PBL instruction that I could use this to make recommendations for teachers who are implementing PBL instruction in the classroom and need guidance for the development of positive student outcomes.

Chapter Four

Results

Introduction

The purpose of this study was to describe the experience of students with disabilities engaging in project-based learning (PBL) instruction through the scope of a class in a small charter high school that uses PBL instruction exclusively to deliver content through integrated learning experiences. The primary question for my research based on the background presented in Chapter One was: How do students with disabilities experience PBL instruction in relation to their supports and interactions with instructional activities; materials and tools; and instructors and fellow students to learn project content? In order to address specifics with this large question, I focused my study on the following research subquestions:

- When and in what ways do components of PBL show up in the classroom, instructional materials, and teaching and learning interactions?
- How does the learning environment scaffold learning for students with disabilities in PBL instruction?
- How do students navigate learning in PBL instruction (i.e., what are students doing when they interact with learning materials and activities and how are they interacting with teachers and peers to learn project content and skills)?
- How do students demonstrate learning of a new content skill in PBL instruction?

Over the course of three months I gathered data consisting of conducting interviews with three teachers of the "Mistakes in Architecture" class (i.e., Ann, Beth, and Sarah) and one student with a specific learning disability (i.e., James) conducting direct, in-class

observations; audio recording interactions between James and teachers as well as peers; collecting copies of artifacts created by the teachers and James; and studying the curriculum documents written by the three teachers. The driving question for the project was: "How do design, communication, and execution impact the success of a commercial building?"

In order to gain the perspective of the experience of a student with disabilities in a classroom using PBL instruction, I recruited one participant with disabilities (i.e., James) who I interviewed; completed direct observations of him and his collaborating peer (i.e., Eli, a student who worked closely with the focal student through most of the project) during class sessions, and his interactions with teachers in class (i.e., Ann, Beth, and Sarah). I analyzed James' work and conducted "quick questioning" through a brief 5-minute conversation at the end of class asking about the happenings of the day. I observed Eli through direct observation and quick questioning as well. Also, in order to determine if this classroom used all the components of PBL instruction for the students, I conducted a component analysis across all the types of data I collected to look for the indicators of PBL instruction (e.g., driving question; 21st century skills; need to know). In the following sections I describe the findings from the analyses of these data sources I collected from April 2019 to June 2019.

Component Analysis

The component analysis I conducted on the available research studies for PBL instruction (see literature review in Chapter Two) revealed that not all of the seven components of PBL instruction were apparent in all of the studies I included in the literature review. The inconsistencies in how PBL has been represented in the literature prompted me to examine whether the class in the current study included each of these PBL instruction components. I conducted a component analysis of the data based on the seven components

outlined by Larmer and Mergendoller (2010). I coded the individual components of PBL instruction in the data I uploaded in Dedoose using definitions for the PBL instruction components that I included in Chapter Three. The results of the PBL instruction component analysis across data types (e.g., observations and interviews) are included in Table 5.

Table 5

PBL Instruction Component Presence Across Data Types as Percentage

Data Type	Need to know	21st Century Skills	Driving Question	Voice and Choice	Inquiry and Innovation	Feedback and Revision	Presenting to a Public Audience
Observations (n = 16)	9.9%	6.8%	6.3%	12.7%	9.0%	38.2%	4.7%
Audio Recordings (n = 18)	34.4%	23.1%	28.7%	9.5%	27.0%	10.1%	46.3%
Interviews (n = 8)	21.8%	14.4%	21.3%	35.0%	11.0%	11.2%	2.4%
Targeted Questioning (n = 6)	2.4%	7.7%	1.2%	3.2%	3.0%	3.4%	20.9%
Teacher/Student Artifacts (n = 29)	14.5%	32.6%	27.5%	25.4%	27.0%	11.2%	7.0%
Curriculum documents (n = 13)	17.0%	15.4%	27.4%	14.3%	23.0%	25.9%	18.6%
Total:	100%	100%	100%	100%	100%	100%	100%

Note. Percentages represent number of code excerpts represented in data types compared to the total number of excerpts of the component.

Each of the seven components of PBL instruction were present across all data types (i.e., observations, audio recordings, interviews, targeted questioning, artifacts, and curriculum documents). These findings demonstrated that this was a class that implemented PBL instruction as defined by Larmer and Mergendoller (2010). The relative percentages

represent the number of coded instances of each component within each data type divided by the total number of coded instances for that PBL instruction component. For example, 23% of the inquiry and innovation codes were present in the curriculum documents. This represented 23 codes for need to know found in curriculum documents divided by total of 100 codes for need to know multiplied by 100 (33%). While all of the components of PBL instruction were present across all data types, their individual distributions were not completely equal. In the following section I will discuss feedback, driving question, and presenting to a public audience since they represent components with variation in the data.

The PBL instruction component code of "feedback" was found in relatively low percentages in student and teacher artifacts (i.e., 11.2%), even though they represented the largest amount of individual data sources (i.e., n = 29). I found the largest percentage for feedback (i.e., 38.2%) in the observations. It was surprising that the student and teacher artifacts did not comprise the majority of feedback and revision. This gave me an insight into the nature of the feedback that is essential in this classroom and that it might not be completely housed in the artifacts created by the student.

Another PBL instruction component code that was not represented equally across the five data sources was the driving question. The driving question was underrepresented in the in-class observations (i.e., 6.3%) and the targeted questioning (i.e., 1.2%) yet evenly represented in the remaining three data types (i.e., interviews, artifacts, and audio recordings) at 21.3%, 27.5%, and 28.7%. The high percentages for these three categories suggested that the presence of the driving question might not be evident to an outside observer when entering a PBL classroom, but it is present in the planning documents as well as the interactions between teachers and students in the classroom.

The presentation to a public audience component also showed relative differences in the number of coded instances in the data. There were very few representations of the presentation to a public audience code in the teacher/student artifacts, interviews, and observations (i.e., 1.9%. 3.6%, 3.6%) with relatively high representation in the quick questioning, audio recordings, and planning documents (42.8%, 31.7%, and 16.3% respectively). This might be due to the topics James and I discussed in the targeted questioning, and not seeing the driving question overtly in my in-class observations due to my attention on other parts of the classroom interactions.

Themes

I conducted the thematic analysis in order to answer the following research questions: (a.) How do teachers scaffold the learning for students with disabilities in classrooms with PBL instruction?; (b.) How do students navigate learning in a classroom that uses PBL instruction?; and (c.) How do students demonstrate the learning of a new content skill in a classroom using PBL instruction? I used Saldana (2016) as my guide to analyze over 70 hours of direct observation notes; multiple small instances of interactions of the focal student with the teachers and his collaborating peer; practice and final presentations of the focal student for the class; initial and final interviews of all three teachers and the focal participant; and 12 separate curriculum planning documents. The documents included a summary of the entire class produced by the teachers (i.e., the construction document) and multiple samples of the focal student's work. As I described in Chapter Three, I developed codes that then I collapsed into categories and from these emerged the themes based on the research questions for this study. In the following section I will define and describe each theme and subtheme. Please refer to Table 6 for a brief description of the themes and subthemes that emerged from

the data.

Table 6

Themes

Theme	Definition	Key Excerpt
Supporting Students: "Kids sometimes ask for help, but they don't often ask for help across the room"	In a classroom using PBL instruction the teacher promotes student success through direct and indirect support of the student and that creates an environment and curriculum that helps learning happen.	Ann: one of the big challenges that I faced in supporting some of the students in this class was this class it did involve a lot of, reading and writing which a lot of our projects do involve reading and writing and that kind of stuff as well … I had to support a lot of them in a lot of vocabulary work… to really be able to break down those words and understand them
Subtheme: Direct support	Teachers actively interact with and support students during every moment of the class. This includes talking to students to assess where they are struggling; teaching a skill; and giving feedback on progress.	Sarah: I feel like, in our setting, there's a lot of just a lot of, teacher student interaction, and there's more mentoring and sitting in a smaller group kind of situation where you're working closely with a student
Subtheme: Indirect support	Actions of the teacher to make the project flow that do not involve direct student interaction. This includes planning of the project based on knowing the students; knowing the academic content; and being flexible in delivery of instruction.	Sarah: the idea that I see, that it they can make connections, more deeper connections because, the vocabulary they're learning is related to the math that they're learning, is related to the history they're learning.
Student Buy-in: "It usually takes all of our new students about one to two trimesters to drink what she [Beth] calls	To be successful in a classroom using PBL instruction students must accept and deeply engage	Sarah: when the students are, are working, a lot. when the students are engaged a lot. and the

Theme	Definition	Key Excerpt
the Kool-Aid"	with the curriculum and all of the differences that it has as compared to a traditional learning experience in other classrooms. This helps students persist in challenging academic tasks. The depth of their engagement is connected to their academic progress.	students seem happy, and the students are, producing, like, you know progressively better stuff, that when you see at the beginning, and then you see towards the end, at like exhibitions like, even if their exhibition is, not that great but you see how, how they've come, you know, along, that is, that's really nice to see and I feel good about that
Subtheme: Personal Relevance	In order for students to be successful in classrooms using PBL instruction students develop a reason to learn what they are learning. That helps them buy-in to the difficult work in a PBL classroom.	James: another reason I wanted to learn more, cause I used to go to the job sites with dad, and go put wire and, put in outlets and, do little stuff so I knew how to do a lot of stuff but, I wanted to take that class that way, I could learn more, about it
Subtheme: Engagement	Students need to connect with the curriculum, the teachers, and their fellow students. Teachers building these connections with students helps students identify and use supports in the classroom.	Ann: we were just trying to like, find, a meaningfulness in it for them, and trying to help them find, like in some way that they could re-, relate to the project
Subtheme: Pride in Work	Students feel pleased with what they have accomplished in the class, upon reflection, they feel that the work they have done is something important.	Ann: then being able to see that final product of all of those steps and all of those reflections where it got them, like there was one student that started to like tear up once he saw his final book
Teacher and Student Interaction in PBL Instruction is Complex: "You	The interactions between teachers and students during PBL instruction	You take a lot of time to plan out the project, and you have an i- overall idea,

Theme	Definition	Key Excerpt
come up with this idea, you come up with this theme, but you, go with the students."	involves teachers first developing challenging and meaningful instruction that anticipates where students might struggle, and then actively interacting with students during class sessions to assess, remediate, and grow the skills and knowledge of students in ways that address the student's academic needs.	and theme of kind of what's gonna happen, but in reality you come up with this idea, you come up with this theme, but you go with the students.
Subtheme: Responsive Support Needs to be developed by Teachers and Accepted by Students.	Teachers need to offer individualized support to students and recognize that the students then have to accept the support.	Ann: so like one struggle was really just getting the students to, accept the support, [was], um, and, they, they got there, definitely like there were some really successful moments of supporting students that at first they were like, eh: don't help me I don't want your help and then eventually like taking that support, um but initially getting them, to where, because there was a lot of, um, steps in this class, that needed a lot of significant support so like the students being okay with that and accepting it, um, was a challenge like I said it ended up I feel like, there were some very very successful moments with that but like getting that process started like it was a process and it was very slow and, like not pushing the student too much at one time, and just, continually like trying, to support them more and more as they

Theme	Definition	Key Excerpt
		would allow it. Beth: so you're like well, okay, but, sometimes I'll just talk to them and be like are you okay with, like me supporting you in this way because, this is where we're going and I think that'll help us get there,
Subtheme: Challenges	PBL instruction requires both teachers and students to grasp large-scale problems and create a path to answer or solve them. Teachers and students might struggle conceptualizing the scope or a problem and what needs to be done to study it.	Ann: it really is a different style of learning and it's a different process so I think all of them can be challenging and I think it takes students time to, learn them, and, really realize that they're there to help them
Student Demonstration of Learning: "We actually have something to show"	Students' ability to demonstrate their learning in PBL instruction requires synthesis and higher order thinking. Students demonstrate their learning through day-to-day experiences that build their understanding of a larger idea and helps them answer a driving question. This culminates in a demonstration of learning in front of external guests called an exhibition	Beth: sitting in the corner and gluing popsicle sticks together is not going to, get you, credit, 'cause that's not what we're assessing. James: yeah that's a thing that you, just wanna take from all of these exhibitions is that, it's a lot about just learning how to stand up in front of people, and talk last year I did pretty good I did it without no stuttering or anything I just don't know about this year
Subtheme: Synthesis	In PBL instruction students build their knowledge in the class and put it all together to apply their learning to the big ideas in the class. This takes careful planning, sequencing, and support.	Beth: you can't just like, throw, an architectural mistake, at a kid that has never practiced it before and be like cool unpack the whole problem, show me where that happened in the design build process, and

Theme	Definition	Key Excerpt
		apply it to the driving question ready go
Subtheme: Growth in skills and knowledge	The core of PBL instruction is academic content that is contextualized in a project. The day-to-day learning is purposeful to answering the big ideas in the project.	James: So basically uh, o-once they started, once they built the building and everything, the people at MIT found the cracks in the pillars, so they had a crew go in there and figure out what was wrong, and they found out that the joints for the pillars were uh, measured wrong in this place, and that's why they started to crack, that's why the, pillars and everything started to crack. but luckily, they got it in time where it didn't collapse.

Supporting Students: "Kids Sometimes Ask for Help, but They Don't Often Ask for Help Across the Room"

This theme emerged when the teachers and the student were describing the ways in which teachers assisted students in learning academic skills and content during the project. The supports provided in the classroom I studied were varied. Teachers used many different approaches to help students who were not successful in learning skills and content in the classroom. The quote I chose to represent this theme describes that supporting students to learn content and academic skills in the context of PBL instruction is challenging and takes many different approaches. The approaches that I observed teachers using in the project and that participants mentioned were examples of both direct support of students and indirect support. These are described below.

Direct Support. Direct support of students included many instances of "coaching students through every moment" (Beth). By this, I mean that the teachers were consistently interacting with students through the entire time of the two hour and 20-minute project class period. This interaction looked like the three teachers circulating in the classroom and sitting with students individually and in small groups. During this time the teachers were sitting, kneeling, standing in close proximity to the student and focusing their verbal and non-verbal interactions on documents that the students were completing. This subtheme emerged as individual as well as small group support. For example, during classroom observations I noticed that all three teachers were actively working with students through the entire class work time. Beth, for example, described the challenge in finding one of her fellow project teachers within the classroom during a class session: "I don't know where they are so I have to like deliberately, look for them 'cause everyone's like sitting with a kid, like on the

ground, in a chair, like the whole time, for twelve weeks". This statement exemplifies the experience that I saw as an observer in the classroom. Teachers were invariably supporting students through every moment of the project.

Each teacher also discussed how they supported students in PBL instruction. In her first interview Sarah described how she first identifies who needs help in the classroom:

> I know who needs help at this point like I know who to check on more, um, just 'cause I know the students… it's really just looking around and seeing who's actually engaged in the work and who's not.

She later described how she uses conversations with students as a means of identifying the supports students need while in a PBL classroom:

> the ones that you don't know [if they need help] you quickly find out right from just talking, but it really is because we're, we're closely linked to the kids we're talking, there's a lot of, teacher, and student conversation that happens.

In her initial interview Beth also described how she moves through the classroom and checks in with students about their support needs:

> every teacher's floating to every table being like do you need my brain, anybody need a next step? Little phrases like that or like can I sit with you guys for a second and I'll like help you, work through the next thing.

Ann also discussed that the process of supporting students can be challenging: "all of the students need different things and being aware of where the students are at [is difficult] and, just knowing like that's perfectly okay." These ideas expressed by the teachers in their beginning interviews show that they perceived that the challenge of supporting students in PBL was a task that required them to work with the students in "every moment".

Observations of the focal student, James, mirrored the use of ongoing direct support as well. For example, in one observation I noted that Ann was spending a significant amount of time supporting James in developing his final PowerPoint for his exhibition. James was challenged in understanding how all of the little problems in the MIT building were adding up to big problems (i.e., understanding how to problem solve this part of the content). I wrote:

> Ann prompting James about the big problems for the building. She is guiding him through the thinking about the problems through a scenario. She is giving him suggestions about what to put in the ppt for the section he is working on.

The level of help described in my observation appeared to support James in being successful in such a large task as synthesizing his understanding of the problem for the MIT building in the scenario. In fact, he described how he frequently received direct support during the project from one of his teachers: “yeah Ann was always like, well I knew what I had to get done like I knew it wasn’t much so I knew I couldn’t get it done I got it done.” This comment represents an important realization for him: James understood that his teacher knew exactly what he needed to get done next and what he had done so far. Further, he described that his teachers were always there checking in on him and helping him through each step of learning the skills and knowledge to answer the driving question and complete his exhibition. In another observation, I saw the same teacher sitting with him helping him understand similar concepts. This shows that the teacher engaged actively and often with the student in understanding the scope of the problems and how to synthesize them for the final presentation.

Ann also directly addressed James’ IEP goal related to reading comprehension by

developing a small group instructional setting. In one observation the students were divided into smaller groups to read and discuss a reading about one of the buildings they were studying, the Citicorp tower. James experienced small group instruction where Ann was deliberately teaching not only the content of the reading, but strategies to pull information from the text (i.e., annotating). During this observation I noted that Ann was not only reading the article along with the small group, she was also stopping to point out important information as well as teaching students how to annotate the text to remember important information. James experienced small group instruction where Ann was deliberately teaching not only the content of the reading, but strategies to pull information from the text (i.e., annotating). This use of specifically designed instruction aligned with what Swanson (1999) recommended as an effective practice of strategy and direct instruction for students with learning disabilities to learn information from a text.

Another direct support for students that emerged from interviews and observations was the teachers knowing their students well. They felt that part of supporting students to learn academic skills was understanding who students were as people and how their history of school experiences and personal life had impacted them as learners. Understanding the personal lives of students helped the teachers connect what students were learning to what students already knew. This is a foundational component of the UDL concept of multiple means of representation and has been shown to promote student success (Kieran & Anderson, 2019). An example of how knowing students impacted how teachers provided more individualized support for students in this classroom came from one of the teacher interviews when Ann was describing the successes of a student who has not always been successful. Her comment pointed to teachers' belief that they needed to build a connection

with students and know their history in order to engage them in the difficult work involved in PBL:

> I always learn like, you know I learn, specific things about each individual student but then I also learn, that you know, they really want to learn, like, they really do sometimes they might seem like, they're not engaging in it or, whatever but I've learned that if you, make the effort and you tr- try to support them and show them like, skills and stuff…
>
> especially like with her history she just is constantly, disengaged in classes and very, um, you know, but I think with, the, support and again it's building that like it really helped us at the beginning of the trimester she didn't want help, whatsoever, um but building that rapport with her really helped.

This perspective helped me understand that direct supports like "knowing students," as I have defined them for the purposes of this study, were vitally important to the success of students with disabilities in the PBL classroom.

Another type of direct support mentioned by teachers in the study was providing curricular tools such as worksheets, graphic organizers, and/or technology to students to support their learning. Graphic organizers such as these are one of many practices that were recommended by Swanson (2001) as research-based strategies that help students with learning disabilities access and learn information. Jimenez et al. (2007) also noted that graphic organizers are a tool used to implement multiple means of representation and are effective in developing content knowledge and skills in writing (e.g., using a graphic organizer to draft a paragraph). I coded the use of graphic organizers and other similar tools as "Student Tool Use," and indeed, the largest code set under direct support for students

came from this code. For example, in the initial interview Beth described a challenge she had experienced in supporting students with disabilities in classrooms that use PBL instruction. Students did not always know what they needed to do with the tools that the teachers gave them and required instruction in how to use these tools to complete assignments:

> a lot of the kids with disabilities in the class they were struggling because they didn't know how to use the tool. We had a graphic organizer, for how to like write a paragraph and we did a mini lesson to show how to use it… they didn't realize that the different boxes were to help clump things.

In Ann's initial interview she also described how she helped students understand what to do in class based on a type of tool, a checklist, that she gave to students:

> whenever we start a new chunk [of tasks] we'll give them a checklist of things, it's more of like a to-do, kind of list, just so they can go back and make sure they're hitting all the components of what we're looking for in the assignment, and it also lets them know like, okay once you've done this step this step, this step, okay, now you need feedback, so now go see a teacher to get feedback, and then once you get that feedback now you need to do this step this step, this step, oh look, I need feedback again, okay, then step, step, step, and so forth.

Ann and her fellow teachers used checklists throughout the class in order to support student learning. Curriculum documents created by the teachers for the class (e.g., worksheets, guided notes), for example included many checklists and step-by-step instructions for the students to use when they were completing their work. During observations I saw the teachers repeatedly use checklists and guiding documents with to-do lists in order to drive the work for students in class. Checklists such as the ones used in this

classroom help students assess their own progress toward the end goal of the class and are recommended as a part of the UDL process of multiple means of action and expression (Kieran & Anderson, 2019). Deliberate and transparent sequencing and chunking of learning was also a practice suggested by Swanson (2001) as a way to support students with learning disabilities to manage complex learning. I also saw teachers teaching students how to use these tools. In this class for example, when the students were getting ready for their mini-exhibition, a practice exhibition that the teachers required of the students at the mid-point of the class, I noted Beth describing a guiding tool to the class:

> This right here is a checklist that will tell you what goes into your portfolio for the mini-exhibition. It will be bound and look like this [shows example]. There are four parts to this right here at the top: answer the DQ [driving question]. As you guys are looking through, you can organize yourself and see which assignments go with which part. Here you will see that this does not have a to do list because it is new.

There was additional evidence of supporting students in the curriculum documents. In order for students to earn credit in the class they had to complete an exhibition of their work that included a synthesis of their work on a case study of a building that had a design or construction problem. This final presentation included a PowerPoint presentation with 16 separate slides, each with large ideas of how the design-build of a building went wrong and created the problem. In order to support the students through the creation of this slideshow, the teachers created guiding documents that detailed, through a graphic organizer, the ideas that each slide needed to cover. This is another example of how teachers both worked with as well as made the assignments clear for students.

In his post-interview James also mentioned that the tool teachers gave him to guide

his work on the large PowerPoint for the exhibition helped him create his extensive slide show for this culminating assignment:

> I have the paper for all the slides we need, that says what slide's supposed to go from like on the papers it said slide from like, thirteen to like, fourteen or something had to be about this information or, slides eighteen through whatever had to be about this or, something like that.

(I have included a copy of the guiding tool that the teachers gave James and the other students as Appendix G). I found evidence across all the types of data I collected that direct supports like these might support student success in the PBL classroom. However, these types of supports were not the only supports that teachers used to promote student success in the PBL classroom that served as the case study for this research.

Indirect Supports. Observations and interviews with participants showed that direct supports were coupled with indirect supports that the teachers used to help students learn content and answer the driving question. I defined indirect supports as actions of the teacher to make the project flow that did not involve direct student interaction. This included planning of the project based on knowing the academic content and being flexible in delivery of instruction, based on how quickly students progressed or what learning problems they encountered.

Beth discussed in her first interview that routines were an important part of the way teachers set up the classroom: "regardless what our warmup is we try to make it somewhat, pull and tie from the previous class to kind of, bring it together, and then after we do the warmup then we'll go into, what the assignment looks for the day." Further, she discussed that the teachers for this project planned carefully to make the routines more than just

repetitious acts in the classroom:

> [Routines are] something that like my team is working on right now, is, having it not just be, well it's a routine, 'cause we do a warmup every day, but having it actually be something that like is useful in the time. So sometimes it is useful to write a reflection about something you learned.

Later in the interview Beth described some of the ways teachers planned to make the beginning of class routines in the class impactful for the students. This included giving the students checklists as described earlier and describing how the work would be broken up for the class time.

The teacher's use of routines in the classroom for student support was evident in my observations. One example of routines that I observed was consistent daily structure in the procedures of the class (e.g., teachers starting the day with a brief introduction, then giving students work time, and conducting a short wrap up at the end of class). Another routine that emerged was the use of student activities for learning from the beginning of the 12-week project class that were used to complete more complex work later in the class. In one observation I noted that at the beginning of one class Beth gave students an oral overview of the procedures for the class session. In this observation I noted her saying: "For warm up today get out folders, organize them. We're going to do folder checks today we're giving this time to you so you can get organized. You have about five to 10 minutes and then we'll do folder checks." This type of quick overview of the classroom time showed up often in my observations of the beginning of the class work time.

During an impromptu conversation between the three teachers in the project, Beth discussed the importance of establishing the routines in the classroom. The analysis that the

class did on the first building, the Citicorp tower, was used as a template for the students to create an analysis of the building they studied for the final exhibition. Beth described using routines in the curriculum sequencing to get the students ready for their final building case study:

> the first building was the practice of like, it's, it's exactly the same kind of thing and even the same experiences, it's just, the three big hitters were pulled out for the final exhibition, so at Citicorp we did even more versions to show that you could do everything, but we just pulled out the mind map, we pulled out the design build process application, and the driving question answer.

Teachers not only used routines to give students an overview of the assignments for each class session at the beginning of each class, they also incorporated them to foster the analysis of the second building studied. In the teachers interviews, planning routines such as introducing a way to do a task or an assignment, then applying it to a new idea or task were described by Beth as "multiple bites of the apple"; that is, when a student is learning something new, they need to experience and practice it many times in order to learn and retain the information or to perform the skill fluently. In this case study, the teachers created a consistent structure that built a road map for how to analyze the failure of a building:

> the biggest thing really was, just that like, we designed it in a way that like you had the whole like, multiple bites of the apple, we had, like more than one chance for kids to do things but, it was the idea of you have to take it somewhere and do something with it.

The teachers deliberately created an in-depth, multi-step routine used throughout the entire project in order to promote student success in the complex task of analyzing the causes of

architectural failure (i.e., how architects, engineers, and constructors build a building and where the planning or building process can go wrong). As an indirect support through planning, the participating teachers were deliberate in designing the project experiences to support students in learning how to do a complex analysis with the first building as a whole class; they then used those same routines and experiences to allow students to apply their newly learned analytic skills to another building. In her final interview Beth noted some conversations she had with students who were starting the building study for the second part of class and realized that they already had practiced the tools and the process of the building analysis:

> I think a really big one was them realizing, oh my god, I know how to do this, or like I've done this before, or I've done something similar enough to this before, I can do it.

The students' ability to understand how the initial model of analysis with the Citicorp tower applied to their root cause analysis for other buildings was an important aspect of the routines in the class. This large-scale routine with other supports (i.e., small group collaboration) helped students successfully tackle the large analysis for the final section of the class.

When James was asked in his post-interview what content learning he experienced in the class that helped him answer the driving question, he affirmed what the teachers had said was important for student learning in their initial interviews. His comment below illustrates his understanding of how the various project assignments led up to the work on the MIT building that he studied for his final exhibition project:

> I guess by um, I guess by how uh, buildings are actually getting built and how everybody like how the, the people that are drawing the designs for the buildings are

> actually h- how they're doing it and stuff, like learned how to do that… that kinda helped out with the MIT building, like it came more into play with the MIT building like it all made more sense.

James was describing how the "multiple bites of the apple" routine (where the class analyzed the Citicorp building as their first building study) gave him the tools he needed to analyze a different building. Since he had done similar work on the Citicorp building in the beginning of the class, he was better prepared to analyze the MIT building that he studied for the exhibition at the end of the project.

Another indirect support that I identified in the data involved the teachers making clear to the students that there was a point to instruction. I defined this as the teachers developing classroom experiences for the students to use in class that helped them make connections to the larger concepts taught in the class and the connection between class content and the external world. This was evidenced in all data types and emerged as a code with 45 excerpts.

Beth described another form of indirect support for students that exemplified the idea of having a point to instruction: connecting the driving question to the daily work in the classroom. She felt making this connection explicit was important for student learning. She said:

> if it doesn't go back to the driving question okay now what's the point? And I think that also really helps students because if they can see that an assignment is really helping them go back to that driving question and it takes them to that place, it makes the project more meaningful.

An example of the type of indirect that helped students make connections beyond the

classroom was how the teachers framed the mind map that the students made in the class. The teachers created a document that explained to students how to use mind maps for problem solving. This document included two sections. The first section described "why problem solving is important" and the second section described how mind maps connect to problem solving. The next page in the document described how to problem solve using a mind map. This was important because the students were expected create and use a mind map to describe the problems with their building study that led to the large-scale architectural mistake that they described in the final exhibition. Appendix H contains an example of how the teachers communicated to the students how to use a mind map to solve assigned problems for the final exhibition.

Appendix I shows how the focal student used a mind map to describe the problem with his building case study. This document is representative of many experiences of the student in the classroom and illustrates the use of indirect support of teachers and peers. The teachers created the mind map activity to help students conceptualize and analyze the complex problem of a root cause analysis. James was able to use the mind map as an analytical tool to describe the complex problem that the MIT Ray and Maria building posed to the design/build team, how this problem was found, and how it was corrected. For example, on the map James wrote "the cracks was (sic) causd (sic) by inproper spaing (sic) and the joints in the brick". This showed that he was able to detail the cause of failure in the materials. James further explained that "Mr. Gehry was trying to cut cost so this is why the building started to crack."

A discussion I observed James having with another student in class illustrates that he recognized how class assignments and activities were important because they all led up to the

final presentation. He was describing to the other student how the final exhibition was an important experience and he needed to be prepared for the presentation take it seriously:

> James talking to AM about the setup of exhibitions. James told AM that when outside people are going to the exhibition that you need to stand up and be professional. He said that it is really stressful and that you have to take it seriously.

This quote showed how James was able to identify the "point to instruction" for this student in terms of their final exhibition.

Beth, in her initial interview, said, "whenever you create an experience you have to have an idea as a project teacher of exactly how it connects." She described further that if the project experiences connect together to get the students to the "endpoint" that the project just goes better. Sarah also described that designing learning experiences that connect within the curriculum was important for student learning:

> doing the experiences that, that lead up to something, bigger, so you're not just doing this worksheet because you need to figure out how to do this algebra thing. You're learning how to do this algebra problem because it's gonna be important for you to do it in this next step.

In his final interview I asked James about the most challenging part to this class, to which he replied:

> probably, learning all the like communication the design and the detail[ed] scope and all that learning all those different steps to go into making or designing a building, that was probably the hardest.

As a testament to the importance of contextualizing learning through making explicit the point to instruction, James was able to identify components of the design build process (i.e.,

communication and detailed scope) as challenges that he encountered in the class.

Beth and Ann provided powerful examples of how the teachers recognized the importance of planning for connections Beth described in her post-interview the importance of sequencing and connecting learning activities as she reflected on projects she had taught in the past that lacked the idea of planning for connections and the students did not benefit from this:

> A lot of the projects I've taught, they like learned a bunch of cool stuff, but, kids didn't really make connections, the whole point of like, really focus in, really focus in, was to make more connections, than just: we're doin a bunch of stuff.

Ann also described in her post-interview how students in the Architecture project were supported because the class sequencing and student experience flowed and all connected together:

> Looking back on it like I think the layout of the class was very, purposeful, and very systematic in far as trying to scaffold for student learning, um and I think that part was very successful.

Student Buy-in: "It Usually Takes All of Our New Students About One to Two Trimesters to Drink What [Beth] Calls the Kool-Aid"

Another theme that emerged from the data was the importance of student buy-in for their success in a PBL classroom. I defined buy-in as students accepting all of the differences that PBL had as compared to a more traditional learning experience in other classrooms (e.g., lecture and discrete skill acquisition without context in contrast to contextualized learning through real-world activities) and becoming deeply engaged in the learning experiences. For example, James discussed the process of picking the projects that he wanted to study for

the trimester and said:

> the teachers will do a, like a presentation about the class and [talk] about what they're gonna do and, what they're gonna learn in that class and, what's, what's going on in that class and, that's how I usually picked it, and like if it interested me I'll, get more information about it, and then, pick the class.

He described further that he chose the "Mistakes in Architecture" class because:

> I wanted to learn about a little bit about the architecture side, 'cause I was doing the construction in my first project the, with the moving heat with the HVAC side and, I just wanna learn it all, I wanna learn little bit of everything.

Personal Relevance. One component of buy-in for students was personal relevance of project content for individual students. This involved the student identifying a reason to learn the content within a project class. By having a reason to learn, students might be more able to persist to complete the difficult work in a PBL project. When I asked James about what he had learned at the school in other projects that has helped him in other settings beyond school he described:

> well, being with my dad cause my dad's electrician… that's another reason I wanted to learn more, cause I used to go to the job sites with him, and go put wire and, put in outlets and, do [little stuff] so I knew how to do a lot of stuff but, I wanted to take that class that way, I could learn more, about it.

James saw value in what he was learning because that knowledge was of importance to him outside of the classroom context. This and many other examples in this study exemplified the directive of IDEA (2004) to prepare students for post-secondary pursuits as well as the UDL concept of multiple means of representation (Kieran & Anderson, 2019).

James saw value in the work he was doing in class because he chose the class based on his interest in becoming a part of the construction industry. The importance of housing the learning in contexts outside of the classroom showed up later in the interview as well when James was discussing what he liked about the school:

> I took that class, to learn more about it learn the more math side of it and, learn, just a lot more about it that way when I go into it I know, most stuff, like just, there's classes here that, try to help you like, get you somewhere in life.

James felt that even the difficult work in the classes, such as the math required (math was identified in his IEP as an area of need) would help him beyond high school.

The students' need for relevance and connected learning activities was illustrated when they learned about personal budgeting. The teachers had the students create a personal budget as a first step in learning to help the students understand how a large company creates a budget for a project. This budget was introduced through a game where the students rolled dice to be assigned a salary, living costs, and expenses. This activity was engaging for Eli, James' collaborating peer, who went through the exercise and found out that he was going to be in debt each month based on his earning and spending:

> Three for the first one; five; five! ala! the big spender great (500 a month for entertainment). Income is 3080 taxes 180 a month disposable income 2900. And then savings I got 10% so divide my monthly income by ten 308 dollars. Money available for spending 2900 housing and utilities. Oh great I'm going to be in debt. Food, 400 a month clothing 100 entertainment 130 I don't want anything when I am older… shhhhh god 2900 minus 2400 minus 400 minus 60 -160 -240 ala! I'm in debt a thousand dollars. 1200 dollars.

The teachers created a sequence of learning experiences in the classroom that started with a high-interest activity (the budget game) that helped them understand how budgeting not only impacts students' lives (i.e., economic self-reliance). This created buy-in from the students that then helped them then transition into a learning activity that applied those skills to creating a financial proposal for a building. This proposal asked the students to make decisions about the budget of an apartment building build based on what they had learned about facets of business (i.e., certifications, reputation, price bids). These real-world scenarios offered the students the ability to make choices based in real-world contexts. The UDL principle of multiple means of engagement suggests that teachers promote student engagement through student choice in authentic and relevant learning tasks" (Kieran & Anderson, 2019). The financial proposal included scenarios for hiring contractors in which students needed to make a decision between hiring one of two companies. This activity helped the students understand that the decisions that are made in construction might not be solely based on the cheapest bid. James' construction choices activity demonstrated that he could make decisions using critical thinking based on his knowledge so far in the class. This was evidenced in the second page of the financial proposal graphic organizer James created in which he was asked to discuss the qualities of the workers he hired for his proposal:

> Lot [sic] of the people [sic] I piket [sic] were surtafide [sic] to do the work it might have cost a lot but in the end and when the building is done it will be nice. So like the framing I chosed [sic] them because of there [sic] rating and referenes [sic] and fot the excavating to they had good reputatshen [sic].

James' reasoning for his financial proposal was logical and clearly articulated because of the deliberate work the class had done to understand how decisions were made in the realm of

construction. James' buy-in was developed by first having him do an activity of high personal relevance (budget game) and then transferring that knowledge to the financial proposal assignment. This type of carefully sequenced curricular planning helped him successfully engage in very challenging curriculum that had him create a detailed financial proposal for the construction of an apartment building. Based on his interview data these skills will also be very beneficial for him in his pursuit of a career in the trades.

In her interview at the beginning of the project Beth described that creating challenging work for her students affected how students valued the personal relevance of the classwork:

> if they're comfortable the whole time, they don't the kids don't talk about those projects, like after, the fact, when they're like man that project was really cool, it's 'cause there was stuff that was really, really hard that they could do, and they knew that it was really hard, and at the beginning they couldn't do it but they figured it out.

Sarah also discussed this as something that helps students buy-in to a class:

> like trying to find a balance with what's challenging, that'll keep their interest, but that is not too difficult that they become like, you know discouraged because they don't, quite get all the, all the pieces.

Both teachers thought at the beginning of this class that the students needed to be challenged in order for them to see value in the classroom experiences and ultimately learn.

Another aspect of students valuing classroom experiences was the idea that Sarah expressed in her initial interview. She described that once the class catches the students' interest it helps learning:

> think if they're interested in something, they, they go for it, they, you see a lot of

> innovation like creativity like, solving, um, because they, they're interested in where it gets them next, but, how to get them to engage is not very, easy, a lot of times

Later in the interview Sarah discussed how she feels that teachers can encourage students to get interested in a class through promoting problem solving. She discussed how she promotes problem solving as part of a class to get students interested in the topics they study:

> I guess it always starts with an interesting assignment, um trying to find something that's kind of, that, that they can be interested in that, and you do that you know I guess voice and choice right? Like give them, a little bit of slack in terms of what, they're gonna investigate, or how they're gonna approach things.

Beth also discussed how learning needed to be through human interaction, or through human experiences. She felt that in order to get students interested in and remember what they had learned that teachers needed to think differently about what they expect the students to do in class and anchor it in interactions:

> teaching is not, I made this for you, do it, because that's like not very human, and like people don't learn things, in like non-human experiences or they might like, fake learn it for like two seconds, but you don't actually remember anything. So for it to like actually have any weight it needs to be like a personal human experience. So it needs to be something that like you have to actually work, with people.

Engagement. Based on the data, I defined engagement as students interacting (i.e., attention, curiosity, active participation, and interest) with the curriculum, the teachers, and their fellow students.

All three teachers discussed how engagement was associated with student learning in the PBL classroom during this project. In her post-interview Ann, one of the special

education teachers, described that upon reflection, she was questioning some of the decisions that the teachers made in the initial planning of the PBL project in order to promote engagement:

> we did set it up very purposefully the way we did for a reason um so that's why we didn't include [a model build] within the project, but I think for some of our learners that like hands on piece of it really could have culminated what they were learning and made it a little bit more engaging for them.

This showed that teachers were attentive to student attention, curiosity, active participation, and interest during the class. In fact, Beth, the other special education certified teacher in the class, discussed how this project helped her understand that engagement (i.e., active participation) might look different for different students and that completing every academic experience in the classroom is not what defines learning:

> I just I think that really is the engagement thing, because I think I used to have this idea of what a kid needed to be successful in this project: they have [to do] literally everything. Like that's really what I thought: but I made this whole thing, so you have to do the whole thing damn it, 'cause it all fit together, so you did it wrong, you didn't do the whole part, but it would still work… we didn't tell em that but, there were those built in, really seeing like oh damn you really can have a, a damn good exhibition, and really have the learned a lot through the project, and not done the whole project.

This revelation for Beth helped her understand that the students did not need to complete every piece of work in the classroom in order to successfully answer the project's driving question and learn the content. Even though this finding might appear to contradict

the idea of student success tied to engagement, it more importantly points these teachers to the belief that engagement might look different for individual students and promote that students might be engaged even if it means that the student did not complete all of the work. Flexibility in workload for students was another suggestion that Swanson (2001) found as supporting students with learning disabilities. By changing her thinking about what engagement looked like for some students helped Beth understand more about the nature of PBL instruction and what teachers need to do to engage students in challenging work based on the students' needs. She referenced that the teachers and students need to know why they are doing something that is difficult in order for students to be engaged in the work, saying, "I need to remember that it's worth pushing through something being really difficult, if, you know why you're doing it, really deliberately like in the scope of [the work]."

James also described how of being engaged in the class supported learning. He was able to identify engagement as an indicator of who would be a valuable group member in the class. When I asked him what he used to choose his partners in the class he stated simply:

> uh I choose kids that actually wanted to do their work, tryin to get kids that I seen that do their work that always had their work done and, not just messing around or, something; someone that actually wants to do it.

James also described how his own engagement made him a good group member as well: "I get most of my stuff done, like I, I play my part in the group get whatever I need to get done in the group, and then everybody else has to do their part." One thing I noted about this excerpt was that he described what he needed to do first, then what other people needed to do. Later in the discussion he described what he felt needed to be done when people do not live up to their duties as a group member saying, "just, gotta work harder those next couple

days." This showed that he understood that work needed to get done and that when group members were not as engaged as he was, that they all needed to work harder over the next few days to make up the work.

The teachers of the project deliberately discussed engagement and James also discussed what the teachers cited as engagement in the class as being important in positive outcomes for PBL classrooms. Since the participants all valued this component of success in their own words this became significant in my analysis.

Pride in Work. Pride in work emerged as a subtheme of engagement. I defined this subtheme as students feeling pleased with what they have accomplished in the class, upon reflection, and feeling that the work they have done is something important. James was very proud of his work that he presented at the exhibition. During his final interview he discussed how he felt as he finished up the project and showed his knowledge and the skills he had learned through the project:

> It's pretty, weird when you take a look back at all of the [stuff that] you've done when you're doin it day to day you're just like ah whatever, but then, but when you're actually at exhibitions and you have that folder and that, book, that you did all trimester it's like, pretty nice.

Sarah also commented in her final interview that she felt that the students came out of the project with something to be proud of based on their work. She described that the students were proud of their final portfolios of work:

> I think the kids, that were able, to really, you know get a lot of this work done they're all really proud, of their, final portfolios I mean it's just, and they have that book that they can look at, you know it's bound it's like something tangible that they can like,

> you know like oh my, blood sweat and tears, you know right here so, I think it was a really successful class.

The idea of the students being proud of what they did in class, while not a direct measure of the academic skill and knowledge growth showed that students cared about what they were doing in the class. The pride in work code emerged as something that was important to the teachers and the students. Ann discussed in her final interview that one student whom she was helping to assemble his final portfolio teared up when he saw the work that he had completed:

> when they would start they would have something that was very rough and, a- and it wasn't bad, but then being able to see that final product of all of those steps and all of those reflections where it got them, like there was one student that started to like tear up once he saw his final book.

Beth also connected pride in work to the students' knowing content knowledge and skills:

> you shouldn't have to convince a kid, if they're really successful that like, you know this stuff, you s- at exhibition, the ones where you're like wow, you were incredible, it's 'cause they, they could talk frontwards and backwards about it, and they knew that they understood it so they're really proud of it.

Teacher and Student Interaction in PBL Instruction is Complex: "You come up with this idea, you come up with this theme, but you, go with the students."

This theme emerged throughout the data in many different situations. For the purposes of this study I defined this theme as the interactions between teachers and students during PBL instruction that involve teachers first developing challenging and meaningful instruction that anticipates where students might struggle, and then actively interacting with students during

class sessions to assess, remediate, and grow students' skills and knowledge in ways that address the student's academic needs. Ann described the complexity of interactions needed for successful PBL instruction as follows:

> When you are doing project-based learning, and you're planning for a project, you: how do I put this, you take a lot of time to plan out the project, and you have an i- overall idea, and theme of kind of what is gonna happen, but in reality you come up with this idea, you come up with this theme, but you, go with the students.

This quote typifies the challenges that teachers mentioned facing when developing curriculum for a PBL project. Teachers needed to develop a plan for the implementation of PBL instruction that addresses individualized instruction for students with and without disabilities and then navigate the students' daily needs within the context of the classroom. Based on the interviews and observations I divided the theme into subthemes that further describe the challenges that both teachers and students face when interacting in a classroom.

Responsive Support Needs to be Developed by Teachers and Accepted by Students. One of the subthemes that emerged from the observations and interviews was the idea of teachers offering individualized support to students and recognizing that the students then had to accept the support. This emerged from hearing and seeing how teachers engaged with students in order to *create* and offer support, rather than just give support or tell students what to do. The teachers in this classroom that used PBL instruction had to find ways to interact with the students and create supports that the students would *accept*. Beth, for example, described how she would talk with a student to determine out how to help them and include the student's preferences and perceptions in her decisions. "Sometimes I'll just talk to them and be like are you okay with, like me supporting you in this way because, this is

where we're going, and I think that'll help us get there." When I asked Sarah in the initial interviews about how to support students who were struggling in a class, she also described how she persisted until students could accept the help offered:

> you just keep bugging them I guess to, you know but, they have to get there, they have to realize, at one point or another I think, what, what matters to them and if, if, um, because they're not gonna always have somebody, bugging them to do their work so, what do you do with them like, you just continue to, be there.

Sarah described how the first step in supporting students in a PBL classroom is listening to students:

> The process begins with, like, a lot of, listening right you listen to the, to students but you also listen to your co-teachers and you like have a lot of conversations I think about like, back and forth.

Sarah felt that the success of teachers assisting students was to listen to the students as well as each other in developing ways to give and receive supports. Teachers needed to assess what a student was struggling with in the classroom and immediately support and remediate their instruction just as Swanson (1999) suggested. Ann also described how getting students to accept supports was one of the main challenges in the writing heavy Mistakes in Architecture project:

> I had to support a lot of them in a lot of vocabulary work to really be able to break down those words and understand them and so like one struggle was really just getting the students to, accept the support um, and they got there, definitely like there were some really successful moments of supporting students that at first they were like, eh: don't help me I don't want your help and then eventually like taking that

support, … and accepting it, um, was a challenge.

Responsive support was present in observations as well. Students created a mind map using the software program *Coggle* as one of the larger assignments of the final exhibition. James struggled with creating his mind map because he was having a very difficult time learning this software, so he chose to do his mind map using pencil and paper (see Appendix I). I observed James convince Ann that he did not want to use the computer to create his mind map. This discussion went on for only three minutes, but James outlined his struggles and asked if he could just do it on paper. Ann was supportive and asked him if he needed help getting started. This illustrated an important aspect of the supports for PBL instruction as well. Ann described how teachers need to create ways to help students who otherwise want to be successful independently: "Sometimes it can be hard for people to accept that little nudge, um, because they want to be successful, on their own." I witnessed this type of interaction many times in the observations. The teachers engaged with a student by asking questions such as, "Do you need my brain over here?" or asking just as Ann did with James, "Do you need any help getting started?" In another example of negotiated support, toward the end of the project James misplaced his folder filled with all of his work. He was very concerned about how he was going to be able to complete the class and the exhibition of his learning at the end:

Ann: Is there anything else that I can help you with?

James: I think I have it I just need to find my folder.

Ann: Okay let me know when you find it or don't so we can make a plan to make up some of that work you need to do.

I also observed that this type of responsive support was extended to Eli, James' collaborating

peer, who was going to leave class early because he was going on a trip with his mother. During an observation I recorded Ann discussing how to create a final exhibition for him since he was leaving a week before the final presentations:

> *conversation with collaborating peer and Ann about differentiating the class based on what he needs to finish up. He will be leaving a few days early, so he needs to have a separate exhibition.*
>
> Ann: I have an idea based on what your folder looks like I need you to get your folder out [looks over folder]. Ok so yeah, yeah it will probably be about what Ms. Beth and I said because we will give you I's and then you will complete it when you return. If you can finish your final draft of your financial statement, then we might be able to offer you the financial literacy credit.

The teachers were willing to work with both James and Eli in completing the project and doing their final exhibition through a negotiation. This seemed to be an important aspect of how support was offered in this PBL instruction. Students and teachers used conversations in order to determine where the students were struggling, then created a plan to help a student move forward in their learning and their understanding of the content.

Challenges. One of the subthemes that emerged in my analysis was the idea of challenges. I defined this as both teachers and students having to understand large-scale problems and create a plan to answer or solve them. Based on the data, this PBL classroom presented challenges for teachers as well as students in how learning needed to happen. Teachers needed to interact often with students in order to promote access to and the learning of difficult concepts housed in English and social studies standards. The teachers changed their perception of what students and teachers do in order for the students to be successful.

Teachers and students might struggle conceptualizing the scope of a problem and what needs to be done to study it. Beth and Sarah both expressed during their interviews how PBL was different from the learning they had experienced as students. Sarah spoke about her transition from a more traditional instruction to PBL instruction as hard because she was trying to figure out how to make the class curriculum flow and connect to the driving question, and to learn herself:

> I had no preconceived anything that I was gonna, you know, so, I really learned just from, just working with like seasoned teachers and just like, learning how to, move smoothly through a project.

They also mentioned that they had to learn some of the content in projects themselves and rely on each other for support when they were teaching and supporting students. They spoke about how PBL teachers are forced to work together to problem-solve challenges not only the curriculum, but student support. Beth discussed this in her interview:

> If I don't know, what to do next, on a kid like I'll talk to Ann and be like well I don't know how to get him out of this, rut, and then she probably does, or s- or Sarah might know, how to get em out of the rut.

In the initial interviews all three teachers discussed that they felt that they needed to learn how to learn with students. Teachers in PBL might be required to learn completely new information that is out of their content specialties or expertise. This might present a challenge to teachers learning how to implement PBL effectively in the classroom. Beth recounted a conversation that she had with a student in a previous PBL class:

> I have a little bit of training on this but I'm like a day ahead of you, so, we gotta, like if you hit a problem, let's figure it out, but I, am not, like the end all be all expert on

> this, and then they just like puffed up and were so happy ‘cause they, were like teaching me how to do stuff.

Sarah’s background in architecture made her the leader for the architecture and construction content and Beth and Ann used their training in special education to create access to the classwork for the students with disabilities. The three teachers relied on each other to not only deliver accurate content, but also to make high-level learning about a feasibility study of a building accessible to all learners in a high school PBL classroom. Ann discussed this during an impromptu conversation in the middle of class one day when they started talking to me:

> Sarah was, a huge asset in this class because she understood all of that stuff a lot of the application, it was like I can, I can get, kids like, scaffolded to do something, but like what do they need to know Sarah?

Sarah also described her challenges of learning how to teach in the PBL classroom compared to how she was taught:

> in our setting, there’s a lot of just a lot of, teacher student interaction, and there’s more mentoring and sitting in a smaller group kind of situation where you’re, um, working closely with a student, and doing the experiences that, that lead up to something, bigger than what you’re doing today.

Beth described that the process of helping students through the final phases of the class was a challenge because the students were not able to make the connections between what they had done in class and what they needed to do with the final root cause analysis. Having to remind students about the work that they had done in the class while not just giving them the steps to complete the problem was something that Beth noted when she was

discussing the challenges of supporting students with disabilities in the class:

> that final phase of connection happened for the folks that did final exhibitions so not all of them talked about it in the end, but I was going around and talking to kids about like cool so, right now I see that you're stuck, on answering the driving question, let's look back at some of the other things you did, 'cause it might have the answers in it already.

This quote helped me understand that even though the students had, in the design of the class, already been exposed to a detailed example and experiences to build their knowledge and capacity for the final work, that they still needed guidance in order to complete the new task. The practice of prompting students to remind of what they have done before and how they can use that to address a current problem was described by Swanson (2001) as questioning instruction. This is an effective strategy for supporting students with learning disabilities. Beth described how she coached the students through the experience in order to help them understand that they had already learned tools that could help them do their new analysis and needed to identify them and apply them to a new problem:

> Like you may have already thought about this but just with a different frame so you didn't realize it. it's not, all new. So, a lot of getting in that final exhibition space was, helping kids realize the like, it's not, I didn't recreate the wheel, like, seventy times, in the class?

Student Demonstration of Learning: "We Actually Have Something to Show"

The final theme that emerged from my analysis was about how the students demonstrated their learning in the PBL classroom. Student demonstration of learning involved students' ability to synthesize and use higher order thinking. Students demonstrated

their learning through day-to-day experiences that built their understanding of a larger idea and helped them answer a driving question. This culminated in a demonstration of learning in front of external guests (i.e., exhibition). In Beth's first interview she conceptualized successful learning as student's self-recognition of understanding something "they're successful if they know they understand it, it's not just that they understand it, but they know that they get it, and they can tell you all about it".

Synthesis. For the purposes of this study I have defined the subtheme of synthesis in PBL instruction as students building their knowledge in the class and putting it all together to apply their learning to the big ideas in the class. This takes careful planning, sequencing, and support. The quote that exemplified this theme was from Beth's final interview. She was describing how there was a deliberate process to help the students synthesize their understanding of the big ideas for the class:

> You can't just like, throw, an architectural mistake, at a kid that has never practiced it before and be like cool unpack the whole problem, show me where that happened in the design build process, and apply it to the driving question: ready go!

Before the teachers set foot into the classroom, they created a description of the class that included the learning outcomes (i.e., standards) and the general overview of what the teachers expected that students would accomplish in the class. The teachers outlined the goals for the students in the planning document that the teachers created at the beginning of the project. In the document They outlined the two "root cause analyses" of the project: the one for the Citicorp building and the one for the building for the exhibition. The root cause analysis was an architectural study technique that involved taking a problem in a building and determining the scope of the issue then tracing back to the beginning of the planning for

the building in order to determine where the problem originated.

In their final interviews all three of the teachers discussed the exhibition as being an integrated part of the learning in the project in their final interviews. The exhibition was a presentation of a 16 slide PowerPoint about the "root cause analysis" of a problem in one of eight buildings. Ann discussed how the process of the students completing the final exhibition was important in documenting and demonstrating students' learning of the project content:

> to see like the processes that they went through, and to see like, at the process in which they started and the process in which they ended, and, to really see the like in between and to see the final product, really showed their learning and their growth through that specific piece of the project.

Beth discussed a similar idea in her final interview. She felt that the students were very successful in learning to address the complex problems that lead to failures in the buildings:

> just seeing the whole, the whole, you know, seeing the beginning, where they didn't even know what, design build and they didn't really know like, what, the class was really about, to that final point where, you know, in the final exhibitions … they were able to explain like, in each of the phases.

She recounted a conversation with a student how the structure of the class helped the students synthesize what they had learned during the project and make these final connections "'cause it was on purpose, and then, when they went back they were like oh, that helped, ((laugh)) like yeah it did, surprise".

In a conversation I captured between the teachers in the classroom during an observation, Beth discussed that the exhibitions were going to focus on applying the project's

driving question to the root cause analysis of the students' buildings:

> they're truly like, synthesized condensed like they're not gonna be a word vomit, exhibition, or a, I feel like I need to explain literally every experience I had in the class that's like not the point, the point is just, succinct explanation of an architectural failure that I was able to do really quickly and really well, because, I get it.

James felt that he was prepared for the final exhibition when we discussed it in the final interview. When I asked him about the process, he was able to see that what they did with the first building prepared him for the second building:

> The Citicorp yeah we started with that one, did we did a little research on that one and then after that we started uh we got into our own groups, and got into the, everybody different got everybody got different buildings I got the Ray and Maria building the MIT building.

When I asked him if he had to do the exact same thing that he did for the Citicorp building he replied "[uh no it's] little different I had to do a slideshow for the Ray and Maria building".

In James' final interview he described how he synthesized the learning from the earlier part of the class with the Citicorp tower helped him when he was doing the final building study on the Ray and Maria MIT amphitheater. His understanding of the process of constructing a building that he learned in the first part of the class helped him make sense of the root cause analysis on the MIT building for his exhibition:

> We learned how buildings are actually getting built and how everybody like how the, the people that are drawing the designs for the buildings are actually h- how they're doing it and stuff, like learned how to do that. That kinda helped, like when I figured out with the, with the MIT building, like it like came more into play with the MIT

> building like it all made more sense with the, with the building with the MIT building.

James created one slide at the beginning of his final slideshow, he created one slide to address the driving question of the class and set up his discussion of the Ray and Maria Building at MIT. The content of the slide demonstrated that he was able to identify and describe the issue that caused the failure and apply it to the driving question. Here is the full text of that slide:

> Mistakes in Architecture Driving Question. How do design, communication [sic] and execution impact the success of commercial building? The 3 steps impact the [sic] if the building is going to be successful or not. When building something you have to try to not have any mistakes because it costs money to fix it.

When I looked at excerpts from James' digital slideshow for his final exhibition, I noted that there were many instances where he was able to succinctly describe the problems with his building:

> It all starts with the design of the building and how they execute the building process… Mr. Gehry had to find the right materials for the building that would build a good [sic] building [sic] but in the end the materials did not work.

Further in the slideshow James described how the construction team discovered the cracks and then started to fix them:

> the cracks they found were going to cost 1.5 million dollars to fix the amphitheater. It all started with the design of the building… the cracks were caused by improper placement for the joints in the bricks.

In his exhibition James was also able to describe how the root cause analysis applied to the

Ray and Maria building:

> it was going good until the pillars, they found out the pillars were, messed up and the joints were misplaced… right before they opened up they found out that it was, starting to crack and everything. ‘cause it’s a, amphitheater basically, it’s like, bunch of offices and like there’s a big room for like, presentations and stuff, for studies for, the students over there -pointed to slide- and that’s when they figured out the pla- after they figured out the joints or the placements, they uh, fixed it, and then they opened it up to the public and then it’s, doing good ever since and he won awards for it too.

His words demonstrated that he was able to take the skills he had learned in the realm of in-depth inquiry through the experiences starting with the Citicorp building and finishing with the root cause analysis. He described the problems, how they were found, and the final results of the Ray and Maria Building. This quote demonstrated that James had learned the skills and the content knowledge to complete an in-depth study of a complex problem and ultimately present it at the end of the project.

In her final interview Beth spoke about her confidence in the students who took part in the exhibition as being able to link ideas in the class together “if they completed the exhibition, they made connections, ‘cause it was impossible not to, at that point.”

Within the work of the project Beth discussed how when students were getting ready for exhibitions that they started to understand that the work that they had done in the class actually helped them answer the driving question:

> one dude, he got it first a couple other kids got it, but he really got it. he was like, doing his stuff for his final exhibition, and he went, miss, I feel like I already,

answered this question.

Growth in Skills and Knowledge. The second subtheme of students demonstrating their learning that emerged was the evidence that PBL promotes the growth in skills and concept knowledge. The core of PBL instruction is academic content that is contextualized in a project. The day-to-day learning is purposeful to answering the big ideas in the project. In her final interview Beth described how even from the beginning of the project the students were engaged in academic work that pushed their abilities. She described one of the first activities that they had to do in the root cause analysis was to go through the information with the students on the Citicorp tower and take notes:

> we like handed out a sheet that was like tips for taking notes, and I just was like goin hard, and I'm like guys this how, I want you to practice taking notes you may have taken em differently before, you might have never taken notes, but we need to take notes on this building… once I have a board done I'm gonna switch over to the second board then I'm gonna start erasing, but like you're welcome to take my notes, 'cause right now we're practicing… then they started like taking the notes, and then at the end they were like, that was hard miss.

In James' final digital slide show, he was instructed, by the teachers, to fit the problems with the Ray and Maria building at MIT into the steps of constructing a building (i.e., feasibility study, concept, detailed scope, detailed design/engineering, procurement, construction, commissioning start up, and project close out) and then fit the problem into the three components of the driving question (i.e., design, communication, and execution). When I analyzed James' digital slide show looking for evidence of the steps it takes to complete a building project I found significant growth in his knowledge of the process. For example, in

the feasibility slide James was supposed to identify the portion of the mistake that fit in the feasibility study (i.e., will this design work). James wrote “Frank Gehry was the man that drew up the design for the building and that's where the problems happen to start.” James was able to identify that based on his research that the design was flawed from the start. James also described the detailed scope as “detail scope, is where they actually, buy the materials that they need for the building, and see what everything’s gonna cost and whatever, w- whatever they need and, everything for the building.”

When James was talking during his exhibition about the steps of constructing a building, he described how the team found flaws:

> so basically uh, o- once they started, once they built the building and everything, the people at MIT found the cracks in the pillars, so they had a crew go in there and figure out what was wrong, and they found out that the joints for the pillars were uh, measured wrong in this place, and that’s why they started to crack, that’s why the, pillars and everything started to crack. but luckily, they got it in time where it didn’t collapse.

James also was able to discuss how the mistake happened through the lens of the driving question of the class. In his final digital slide show, he had one slide each for the three components of the driving question for the class: “How do design, communication, and execution impact the success of commercial building?” On the design slide James wrote “the Ray and Maria building had a rough start because of the design of the building.” When he described this slide in the exhibition, he stated “design is where you start to design a building, where Frank started to draw it up, and he gave it to a contractor that’s where it all started.” On the communication slide James wrote “when building the Ray and Maria

amphitheater they messed up on the pillars the did not space the joints right."

> He described the problem with the communication in the exhibition as:
>
> Communication it all started with Frank not, doing the pillars right on the design, and then when they did when they actually built it it all, it all just, started falling apart and everything on them so, communication is key when, we're really trying to build a, a building like this.

Finally, on the execution slide James wrote "they found the problem and they had to figure out how they were going to fix it and how much it's going to cost. It ended up costing 1.5 million dollars." As he showed this slide, he said:

> Execution is where uh they found the problem, they figured out how much it was gonna cost, and then they f- they fixed it that way there was gonna be no more problems with the building. That way they could open it up to the public.

In the final exhibition James discussed how the skills and content he learned through the project helped him answer the driving question of the class when he was studying the MIT Ray and Maria Building:

> [What helped me was] basically by doing the Ray M- uh Maria building what, what went wrong and why uh, how everything went down with the design and then, how it went through everything and actually got built and they found the problem, I got act- that helped a lot with the, the driving question.

James went on in the exhibition to discuss in detail the problems that the building experienced and how they discovered them. This quote helped me understand that the learning process in PBL was not just evidenced by the feeling of the students and teachers about the pride of their work, but more so that the students completed a complex study of a

building and was able to synthesize it and communicate it to an audience of fellow students, teachers other than those of his project, and outside guests:

> [They found the problem] while they were finishing up construction, like right before they opened up they found out that it was, starting to crack and everything. 'Cause it's an amphitheater basically, it's like, bunch of offices and like there's a big room for like, presentations and stuff, for studies for, the students over there and that's when they figured out the pla- after they figured out the joints or the placements, they uh, fixed it, and then they opened it up to the public and then it's, doing good ever since and he won awards for it too, in the end.

During the exhibition an outside guest asked James what helped him the most he said:

> I don't know, I guess by, by everybody helping me with like my slides and like all my books and everything like, like getting an understanding of the two buildings that we actually did, actually kinda helped.

The thematic analysis revealed essential components of the experience of a student with a disability in a classroom using PBL instruction. James' experience was complex, and the components needed to be successfully interconnected. I found that supporting students was essential and shaped all of the other components. The interconnectedness of all four themes created a map of the student experience in PBL classrooms that emphasizes many aspects of what the teachers and students need to do in order to ensure that students with disabilities can successfully navigate their experiences in PBL instruction and gain academic skills.

Chapter Five

Discussion, Limitations, and Moving Forward

No knowledge is entirely reducible to words, and no knowledge is ineffable (Papert, 1993, p. 96).

The question driving my study was: How do students with disabilities experience PBL in relation to their supports and interactions with instructional activities; materials and tools; and instructors and fellow students to learn project content? I was able to develop an understanding of one student with a disability's experience at HHS, a school entirely taught with PBL curriculum, over a 12-week project. I used initial and final interviews with the student and his teachers, observations, targeted questioning, audio recordings, curriculum documents, and artifacts to capture the experience of James as he navigated and negotiated his learning about the process of creating a building, making mistakes, and fixing them. Although I found his experience was not unlike a typical experience in a traditional classroom, his experience in a classroom using PBL instruction revealed that there are distinctions in the support of students that need attention from teachers. His experiences in the class revealed unique ways of supporting James and his colleagues to learn complex ideas in architecture and created an environment that promoted not only his academic growth, but growth in his ability to connect what he was learning to his own life. The experience also enabled him to engage in contextualized learning that would not otherwise have been accessible to him, not for lack of ability, but lack of opportunity. In the previous chapter I outlined the themes that emerged from this case study. In this chapter I will discuss how these themes connect to and inform research and practice. Three central findings from the study add to a deeper understanding of the experiences of students with disabilities in a

classroom using PBL instruction: academic PBL instruction needs to be connected to students' lives, teachers in In PBL instruction provide extensive support for all learners, and PBL instruction has the power to engage students.

Academic PBL Instruction Needs to be Connected to Students' Lives

In this case study, a salient finding was the importance of creating academic content and instruction housed within topics relevant to students' lives. The teachers and James all spoke of the power of students connecting the academic work they did in class to their lives outside the class. Students had chosen to attend this school to learn construction, engineering, and architecture, something that they thought was important in their own lives. James, for example, saw a reason to engage in the class from the start. His father was an electrician at the time of this project. James saw value in the classroom academic instruction and activities as a way to open opportunities for him after graduation. He stated that he chose the "Mistakes in Architecture" class because he had not learned much about the architecture aspect of construction. As Papert (1993) argued, James' environment outside the classroom (i.e., his desire to learn the trades he saw his father using) helped him connect the academic content in the classroom to a larger purpose. Kieran and Anderson (2019) would see this connection to the outside life of the student as essential in developing learning through a UDL lens. Developing the skills and knowledge necessary for James' life beyond high school in the area of independent living is also consistent with the goals of IDEA (2004). For James, seeing this connection between the classroom and the environment promoted his academic learning.

The teacher participants in this case study discussed that they first need to identify the learning experiences needed to happen in the classroom that would prepare the students to

create a root cause analysis of an architectural failure. They created connected lessons that started with concrete examples of how design and construction mistakes happen. In the "groundbreaker" (i.e., starting event of the classroom) students were instructed to make an origami sculpture progressively, passing the folded paper from one person to the next at the different steps of the process. This simulated the process of constructing a building with many steps and many parties responsible.

The teachers also created a sequence of experiences in the classroom to help the students understand the potential problems that can happen with small budget decisions on a project. This string of activities started with a personal budget game and progressed to the students making decisions as a real estate developer who was making decisions for subcontractors building an apartment complex. The ability of the teachers to break down complex learning completely to an initial engaging activity and then lead the students through related carefully sequenced activities allowed the students to access the learning in concrete initial steps. This careful planning reflects Papert's (1993) ideas of teachers being anthropologists and finding not only what is important in a student's life, but the concrete and accessible ways to engage students in academic learning based on their environments.

Teachers Need to Provide Extensive Supports for Learners

Another important finding from this case study was the importance of teachers providing extensive, individualized supports to students in PBL instruction to facilitate their learning and academic success. James and his teachers described many different ways that teachers scaffolded and supported his learning (and the learning of the other students) about the design-build process in construction and how to communicate his learning. Supporting students was the most well-supported theme in my analysis with 13 child codes and a total of

456 excepts among the child codes. The volume of excerpts spoke to the importance of this aspect of PBL.

Support in this PBL instruction classroom case study involved both direct and indirect supports. Teachers worked individually in the moment with the students and the teachers carefully planned and sequenced curriculum experiences for students in order to scaffold their learning. In this inclusive setting James, a student with a specific learning disability, experienced teachers addressing the goals of IDEA (2004) for students with disabilities through the wan in which they planned, sequenced, and delivered instruction: equal educational opportunity; preparation for independent living; full participation in educational experiences; and developing skills needed for economic self-sufficiency. This was accomplished through the careful planning and execution of the learning in ”Mistakes in Architecture” and the deliberate actions of teachers addressing the individual learning needs of students with disabilities in a contextualized inclusive classroom. James was ensured access to the general education curriculum through a variety of means including specialized, individual instruction (e.g., strategy instruction), and was able to learn skills that support independent living and economic self-sufficiency through the development of a personal budget and high-interest relevant topics that directly addressed his post-secondary transition goals in his IEP.

PBL instruction is complex and difficult to implement well. The foundations of PBL instruction emphasize interaction in the classroom between teachers and students through meaningful and connected learning experiences that all help the students learn how to address a difficult problem or project and present their learning. The teachers in this classroom that used PBL instruction were successful at connecting the learning and

supporting students in their learning to develop an understanding of something that very few of the students knew anything about before this class. Supportive interactions between teachers and students; and planned, connected activities all developed the experience of James and other students in the classroom. His experience and the experiences of his colleagues offer a unique look into the successes and challenges of implementing PBL instruction.

The power of interaction in this case was evident in the ability of James to complete a complex study of an architectural failure. Kilpatrick (1929) posited that the measure of successful teaching is when the teacher has guided the student enough to develop learner independence, and thus remove the teacher from the success of the action. That seemed to be present in this classroom. The teachers developed the skills and requisite knowledge of the root cause analysis and then coached the students through a second analysis. The gradual coaching of the students towards independence showed up in the teachers' descriptions of the students as they prepared for their exhibition. This classroom exemplified the ideal that Kilpatrick promoted for education and ultimately helped students develop independence in their learning of complex concepts that might not have been attainable otherwise. The teachers in this classroom also used evidence-based instructional techniques proven to support students with learning disabilities (e.g., through the use of guided reading and strategy instruction: Swanson, 2001).

One effective means of supporting students in PBL that was strongly evidenced in the case study was teachers' ability to "coach students through every moment." Teachers interacted with students frequently throughout classes, teaching, guiding, giving feedback, and managing student learning. These interactions through curricular tools, direct interaction

with teachers, and direct interaction with other students positively impacted James' academic content learning and set up the environment of the classroom to have teachers and students support learning.

The need for students to engage with each other as well as the teachers engaging with the students pointed to the importance of interactions in order to promote learning in classrooms using PBL instruction. Teachers did not prompt the students in the class to help each other out. The students took it upon themselves to help each other. The collaborative and social learning environment of this classroom was exactly what Kilpatrick (1929) asked of schools that taught complex instruction like what the students experienced in "Mistakes in Architecture."

All three teachers demonstrated throughout this study that in order to promote success for students in their classes they needed to help students not only start their work during the class time, but continually monitor, give feedback, and help students along their way to understanding how to complete the class assignments and ultimately help them create their final analysis for the exhibition. As I described in Chapter One, Tsai et al. (2015) found that teacher initiation of work (i.e., helping students to start their work during project time) was more effective in projects being completed than allowing students to self-manage their own time and project work. Kirschner et al. (2006) also thought that inquiry-based instructional methods did not include sufficient teacher-guided instruction. Both of these concerns in the existing literature were addressed in the current case. Based on data collected in this study, students with and without disabilities were supported through the entire class in many ways.

Indirect support of students was also critically important for the success of James as well as all learners in this PBL classroom. The indirect supports I discussed in Chapter Four

highlighted some of the impactful actions that teachers take to create a classroom that makes direct support manageable. One of the indirect supports I identified in the analysis was the teachers' deliberate planning and sequencing of connected instruction that promoted the understanding of the driving question for the class through each activity.

Supporting students through planning and sequencing the class to arrive at the final product and deliberately supporting students through the entire process connected directly to Dewey (1933) and Kilpatrick (1929). The teachers created connected learning experiences for the students in order for them to see the purpose in what they were learning through the class. When the students understood the purpose of the classwork they were doing for the project, it helped them make the necessary connections between the ideas that helped them answer the driving question and complete the final root cause analysis for the class.

PBL Instruction Holds Power to Engage Students

Architectural failures are not the typical high school curriculum. In fact, outside of schools that use PBL instruction in the context of the construction industry, they might be non-existent. The power of PBL instruction as implemented in this classroom to engage learners who do not see value in school experiences cannot be overstated. James is one of many students with disabilities who is in danger of experiencing underemployment and unemployment at higher rates, as noted in Chapter One. The Office of Special Education and Rehabilitative Services (2019) reported that 45.3 percent of learners identified with SLD in New Mexico are served in the inclusive general education setting (i.e., 80% of the day in general education settings. Also included in this report were the data that at the national level, students with learning disabilities have a dropout rate of 16.7 percent. Contextualized learning in an inclusive classroom such as what James experienced in "Mistakes in

Architecture," offers the promise to keep students like James engaged in school. By keeping students with disabilities engaged in school, teachers can make them less likely to become a dropout like the Office of Special Education and Rehabilitative Services (2019) noted students with disabilities risk. The dropout study I cited in Chapter One emphasized that personal relevance is important for keeping students from dropping out of high school (Bridgeland et al., 2006). Bridgeland et al. reported that the reason for dropping out cited by the students surveyed in their study was their school experiences' disconnection from meaning in their life outside of school. Creating effective instruction that supports students with disabilities to stay in school is also aligned with the goal of IDEA (2004) for preparation for independent living and economic self-sufficiency.

Papert (1993) talked about how most students in traditional classrooms do not get to experience engaging curriculum because teachers focus on developing skills before allowing students to access engaging curriculum. He described one of the many problems, in his case with math and physics education, that keeps students from engaging in rich opportunities for in-depth learning:

> Most physics curricula are similar to the math curriculum in that they force the learner into disassociated learning patterns and defer the "interesting" material past the point where most students can remain motivated enough to learn it. The potential ideas and the intellectual aesthetic of physics is lost in the perpetual learning of "prerequisites." (p.122)

Allowing students with disabilities to engage in the "interesting" curriculum while learning necessary knowledge and skills also was emphasized in IDEA (2004) as one of the goals for special education services. Students should have equal educational opportunity

through access to their least restrictive environment. PBL instruction in this case allowed James to experience the general education curriculum with supports in place to help him access typical curriculum while allowing for his skill development contextualized in high-interest learning.

In other types of school settings James might have been in "prerequisites" for his entire school career, never getting to the interesting material that he found meaningful because he had deficits in his core content areas of reading, writing, and math. Papert (1993) argued that prerequisites should be built into the engaging experiences so "learners can become the active, constructing architects of their own learning" (p. 112). This idea seemed to be an important aspect of the experience of James at HHS. He was given the opportunity to learn needed academic skills through the complex context of architecture and not denied this rich instructional context to develop his skill deficits. Teachers in the classroom I studied not only taught basic skills but housed them in the context of interesting and challenging projects and ideas just as Papert and IDEA (2004) suggested should happen. This seems a critical component to the power of PBL to engage students with and without disabilities.

James fits the profile of a student at risk of dropping out at any school. Nonetheless there was significant evidence of his ability to engage and persist in complex work (i.e., engaging in creating multiple drafts, revisions, complex inquiry). Even after he lost the majority of the work he created, at the end of the project he relied on the knowledge base that he acquired through the class and the assistance of teachers and other students to complete his exhibition and ultimately pass the class. As documented in this case study, PBL instruction seems especially helpful to engage students who are at risk of not completing high school.

Implications for Practice

There are a few lessons that educators can learn from this case study about how to implement PBL in settings that employ such as more traditional school structures (e.g., classrooms with one teacher in schools that use a traditional school calendar). In the following sections I will describe three main implications for practice that could be taken from this work. These include using an extensive planning process for the classroom project, continuous and regular common planning time for teachers who are teaching using PBL instruction, and teachers capitalizing on the social nature of learning.

Extensive Planning

All three teachers in this study discussed the importance of planning out the project and the learning experiences that the students needed to help them answer the driving question. They felt that planning was an important factor in the success of the project and their ability to support all learners, especially those with disabilities. At HHS the teachers have at least one full week of planning and designing projects before they start the class. This length of time might not be practical in all settings, but some of the steps for project planning are available in a typical setting.

One of the steps teachers need to take to develop PBL instruction is collaborating with community partners to develop purposeful and connected projects that are anchored in a need or problem in the community. This helps the students and teachers see purpose in the class and the content-based work they need to do in the class. By framing the classwork in the external meaning of a need or problem the students might be more engaged in the daily work and develop the persistence that James exhibited in the in-depth inquiry of “Mistakes in Architecture” as well as address the goals of special education services and IDEA (2004)

through connecting his learning to his life after high school.

Another important component of designing projects that can be implemented in other settings was the teachers developing connected, sequenced experiences that build off of each other in order to prepare the students for the final project of the class. The teachers all noted that because the plan for the class was clear and purposeful in preparing the students for the root cause analysis for the final exhibition, they were able to be very deliberate and thoughtful about the supports they could offer students in the class. Connected learning experiences in the classroom as I witnessed in this case study offer the promise of assisting teachers in supporting students more deeply than if the content classwork was not connected.

Continuous and Regular Planning Time

The ability for teachers to have regular and common planning time when using PBL instruction is another important implication for practice I derived from this case study. The teachers described that they were able to meet weekly during common planning time to discuss the content, experiences, and supports for "Mistakes in Architecture" and that this was important to the success of the project. During the weekly planning time they were able to anticipate needs of students based on the next steps in the plan for the class that they were implementing. Common planning time will be critically important for teachers implementing PBL instruction in other settings that do not have the ability to preplan the project as much as the teachers at HHS were able to plan.

Many schools have structures in place to offer teachers collaborative time in addition to common preparation time. One of these structures is the professional learning communities (PLCs). Professional Learning Communities can be a space where teachers not only develop projects, but also bring curricular or student concerns for study and feedback.

Professional Learning Communities give teachers the ability to direct their professional time toward classroom and curricular needs and therefore might be a powerful tool for teachers to utilize in the implementation of PBL instruction in more traditional settings.

The Social Nature of Learning

Teaching is a social act. The teachers in this case study all discussed how they spent deliberate time developing relationships with students to better support learners. In this setting I observed teachers discussing the students' out-of-class lives and working to make relationships with their students to better understand how to support students in class. Educators looking to implement PBL in their classrooms should learn from this study that relationships between teachers and students are a powerful tool that can be leveraged to understand how to support students as well as help them persist through difficult classwork.

Even though this classroom using PBL instruction was mostly based in individual work for students, the social nature of students helping each other learn the classroom was evident through my observations. Teachers should deliberately work to promote the ideal that Papert (1991) discussed about changing students' thinking to understand that when they encounter a problem with something that they have designed or are working to solve, that it is fixable, and not correct or incorrect. This switch in how students view knowledge might be promoted by creating a community of collaboration in the classroom where students help each other learn content and processes for learning, much as I witnessed in this classroom. The idea that problems can be solved or fixed is an essential mental model for students in a classroom using PBL instruction and it can be promoted through teaching students how to engage in learning content and processes from each other. Teachers need to teach students how to teach each other, without taking the experience of inquiry from the learner in need of

support. Students need to be taught how to promote deep thinking with each other instead of giving answers to each other. The support I witnessed students giving to other students was much more based in this realm than just giving each other answers.

Implications for Special Education Teachers

Along with the recommendations for PBL instruction for all students described above, there are specific suggestions for educational professionals who are supporting students with disabilities in classrooms using PBL instruction. First, the need for collaboration between general and special education teachers is imperative. Collaboration improves implementation of instruction toward IEP goals and allows teachers to determine when and how to modify or accommodate learners' unique learning characteristics. Professionals supporting students with disabilities will, as I saw in the current case study, have an understanding of the specific needs for the students with disabilities in the class. They can use this understanding to develop and implement specialized instruction as needed. The three teachers in the class I studied, for example, all mentioned that they relied on each other's strengths (i.e., in content and context knowledge and special education teaching methods) to create effective instruction. There were instances that the special educators in the classroom took a small group to read a selection that was leveled for struggling readers, and the teacher took the students through guided reading and note taking to help students access information from the text. Special and general education teachers implementing PBL instruction will likely need to create small-group experiences, especially to start students on difficult research tasks, or large projects not only at the beginning of the project, but throughout the duration of the project during PBL instruction.

One of the foundational skills needed for success in classrooms using PBL instruction

is students' ability to manage their work on assignments independently (i.e., using effective time management). One recommendation that comes from this study is teachers providing students with checklists of assignments broken down into steps. Another important factor is teaching students how to use the checklists, as was seen in this study. Teachers then need to regularly reference the checklists, prompting students to use these tools to keep track of work completed and work left to complete. Self-management tools, such as checklists, have long been used in special education contexts to support student learning. Incorporating them into a classroom employing PBL instruction is an effective way to facilitate students' success and address concerns raised by previous research (Kirschner et al., 2006).

Providing individual instruction as needed for students with disabilities may also have been needed in classrooms using PBL instruction. This was effective in the classroom studied in this research. James received substantive help when he needed it, in addition to the many universal supports built into the classroom to support all students. There were multiple instances of teachers sitting with James for extended lengths of time in order to support his learning and promote his understanding of how to do work and how to check his progress on work. Teachers implementing PBL instruction in their own classrooms need to provide ample time to work with students with disabilities individually in order to promote academic success and teach independence.

Limitations of the Study

While my study described the experiences of a student with a disability in a classroom using PBL instruction, and it has clear implications for practice not only in this setting but other settings where teachers want to implement PBL instruction, there are some limitations that should be addressed in future studies of students with disabilities in PBL. In

this section I will describe those limitations and discuss how those limitations might impact future research.

One significant limitation of this study was the single participant with a disability. James represents most students with disabilities at HHS in that he has a SLD and identifies as Hispanic. As noted in Chapter Two, there are minimal studies examining PBL that have focused on students with disabilities as participants and even less as focal students. This study provides an example for future research to include participants with disabilities. In the event that I get to replicate this study I would focus my attention on other settings (e.g., traditional, large schools implementing PBL instruction in inclusive settings) that implement PBL instruction through their entire curriculum and attempt to recruit students with more significant learning needs for the study. Future research in this area should deliberately recruit participants with low-incidence disabilities to augment and grow this meager literature base.

The number of teacher participants, while a benefit to the students in the classroom is a limitation of the study. HHS offered a co-teaching model for the classroom. In "Mistakes in Architecture" there were two licensed special education teachers and one licensed general education teacher for a total of 29 students. This is not the typical experience for most high school teachers. The ability of the teachers to offer the level of support that I observed in the class might not be available for all learners in other settings where teachers want to implement PBL instruction. Educators looking to replicate the experiences of James need to understand that this case is exceptional in the ability of teachers to support students because there were three teachers. Even though this might not seem practical for all settings, the students in "Mistakes in Architecture" needed this support to develop their understanding of

the complex problem of a root cause analysis in this context and ultimately was a good decision for the learning of the students.

Further, I believe my novice researcher skills created some limitations to the study's design and implementation. My ability to navigate the potential participant pool as a new researcher might have been a set-back to the study. Families might have chosen not to participate because they were not comfortable with the explanation that I provided and felt that their child would not benefit from the study. Also, my ability to participate as a researcher might have been limited by my position in the school. Since I was seen as a teacher-leader this might have impacted the ability for me to recruit students with disabilities in fear of being watched by a school leader.

A practical limitation that I encountered based on the physical environment of the classroom was my inability to video record the observations. Originally, I wanted to video record classroom observations because it can provide contextual data (e.g., facial expression, and non-verbal communication) that audio recording cannot (DuFon, 2002), but that was deemed too invasive by the Institutional Review Board. I wanted to video record the interactions in class because there are many non-verbal and nuanced interactions that take place in the classroom and this would have provided a rich source of data to round out the experience of James in the classroom. This would have also helped me significantly by allowing me to review my observations afterwards, but in light of the sensitive nature of my participant's status as a student with a disability, protecting his rights as a participant were far more important than the ability for me to review my observations.

A significant limitation to the study was the setting. HHS was a small, charter high school that not only had inclusive classes, but multi-grade level classes. These characteristics

are not typical of a more traditional class or school (e.g., only 45.3% of students with SLD in New Mexico receive services in inclusive settings for 80% of the day: OSER, 2019). A study examining how to implement PBL instruction in a more typical setting with students with disabilities (e.g., a large, comprehensive high school) is needed. Further, the grade level of students in the classroom could have influenced my findings. The findings might have looked very different at different grade levels. This study did, however, give an understanding of how to support students in a school that used PBL instruction in all classes.

While this case study described the experiences of a student with a SLD in an inclusive classroom using PBL instruction, there were portions of the experience that I did not observe that would have promoted learning. In particular, this project did not emphasize student collaborative work through the study. Collaboration looks different in different classrooms, but the emphasis on independent work in the class was more than I would expect in a class using PBL instruction.

Further, I noticed that the students did not establish a need to know with the teachers (a component of PBL instruction; Larmer & Mergendoller, 2010). In my observations and all of the artifact data the teachers never took inventory of what the students needed to know in order to start their analysis. The teachers were able to help the students understand the importance of studying the design-build process and how it can break down and cause costly mistakes, but they did not solicit input from the students to determine what the students thought they needed to know in order to solve the problems of "Mistakes in Architecture."

Another problem with this study was the small number of participants, and lack of potential participants with low incidence disabilities. Since the classroom I studied was in a charter school (i.e., a school of choice), I did not have the ability to recruit students with low

incidence disabilities because there were none in the class. In a school of choice, students are able to choose to come there or choose to leave. Since this choice involved parents transporting their students to and from school, or the students relying on public transportation, this setting might have been inadvertently biased against students with intensive support needs.

As a White, middle class male, the lens that I bring to my research affected how I viewed and interpreted the data collected in my study. I value education as a tool to emphasize and pass down what is important in society. Given that, I see value in offering different approaches to education than typical pedagogical methods in order to engage students who might not hold the same values as I do in education. This aspect of my lens that I bring to research influenced my ability to see different cultural aspects of the classroom that I might have seen if I did not hold the privilege that I hold.

While James represented the majority of the school based on his demographics (i.e., Hispanic male), this is not the case with other schools or other settings that might implement PBL. When looking at this case study, future researchers should understand that while in this school James represented the typical participant that I could recruit, that his ethnicity and gender play into his interactions in the classroom and might have been different had he not identified as Hispanic and male.

The teacher participants' ethnicities and gender might have impacted the results as well. Beth and Ann were both young females who identified as White. Sarah was older and identified as Hispanic. How these teachers operated in the classroom might have been influenced by their ethnicity and gender. One particular observation that I noted was that Sarah invariably helped students with English language needs. Sarah's interactions with

James were limited and might have offered a different perspective on how supports were offered to him and his interactions in the class.

As I described in Chapter One, I am vested in PBL instruction. It has shaped my professional life for at least ten years, and I have placed great importance on determining how to make it work well. This inherently makes me inclined to find positive results in this study. Being so invested in this method of teaching allowed me to understand nuances of the practice and then helped me develop my analysis, but it also might have made me less likely to notice problems or concerns or to critique the pedagogy observed.

My theoretical lens also impacted my ability to determine the experience of a student with a disability in this setting. Had I developed a lens through another theoretical framework than sociocultural constructionism, I might not have focused on and developed the analysis I did in this study. My attention toward interaction and supports might have looked different from a behaviorist or critical theorist perspective and resulted in different findings.

Moving Forward

In this case study PBL instruction promoted the learning of a student with a disability in a general education classroom. The positive learning outcomes were the result of tireless work of the teachers who developed a contextualized, connected, and rigorous experience for James and his colleagues. The amount of deliberate planning that was necessary for this project to be successful at promoting learning of complex ideas cannot be overstated. This project class was the result of multiple weeks of planning beforehand (for an example see Svihla et al., 2019) and tireless hours in the classroom supporting students. Moving forward, if PBL instruction is implemented in large scale across many academic settings, this case study provides insight into the power of carefully connected planning as well as the power of

supporting students through every moment of a class. These do not come easily and are the culmination of curriculum development that is meaningful not only to the context of the classroom, but the context of students' lives. Schools wishing to implement PBL instruction well might look to this case to learn how its implementation in this unique setting with attention to the needs of students receiving special education services as well as attention to the principles of UDL and how they might provide some insight into how it could be implemented in other settings.

As I discussed in Chapter Two in the PBL instruction component analysis, the need for implementation fidelity measures remains apparent in the PBL instruction literature. Future research should include measures of implementation fidelity (e.g., Culclasure et al., 2019). Culclasure et al. created a tool and a rubric to measure implementation fidelity through direct observation of classrooms implementing PBL instruction. When researchers are interested in developing studies that examine PBL instruction as a focus, they should use rubrics and tools like these to measure implementation fidelity of the implementation of PBL instruction in the setting in order to speak to the strengths and limitations of the components of PBL instruction present in the classroom.

Research interested in determining more about the experiences of students with disabilities in classrooms using PBL instruction should consider other participants with a variety of disabilities, especially people with low incidence disabilities. Recruiting people with low incidence disabilities into studies like this one might be an opportunity to understand the scope of the experience for all learners experiencing PBL instruction and how the goals of IDEA (2004) can be ensured with future students. Only with deliberate actions by researchers to include participants with low incidence disabilities will the research base

expand to learn about how these learners might benefit from this type of instruction.

As far back as the early 20th century, Kilpatrick and Dewey were concerned with meaning and purpose in education. As I mentioned in Chapter One, Kilpatrick (1929) argued that purposeful acts are the basis of a worthy life in a democratic society, and that education should itself, become life, instead of preparation for later life. The perspective I argue for the experiences of James was that his understanding of how his family operated in the construction industry was changed and his understanding of the design-build process presented in "Mistakes in Architecture" added to the experiences of his life and therefore might have changed what is possible for him in the future. For schools that plan on implementing PBL instruction like this case I would strongly suggest that the teachers anchor their curriculum in purposeful acts that contextualize and connect learning to the students they serve.

The experience of James and his teachers exemplified what Papert called the art of learning. Both teachers and students in this classroom case created an environment for the art of learning. Teacher preparation focuses on developing best practices based on research. These programs address learning, but teaching is emphasized. Papert (1996, p. 10) argued that schools operate as if teachers are the only ones in the classroom with expertise. This emphasizes the teacher as being in control and the one needing the skill. He argued that it is interesting that education has a word for the art of teaching *pedagogy*, yet no word for the art of learning. In this study it is apparent that the teachers were learners as well, so the environment that the students and the teachers built in this classroom promoted the art of learning.

I started Chapter Five with a quote from Papert that emphasized that not all learning

can be put into words and yet words are needed to describe it. I think this is the case with James' learning in this classroom. I was able to partially describe the teaching and learning that happened in "Mistakes in Architecture" through my own lens and make it fit into existing structures of education that I hold as valuable. Yet there are some components that have escaped my description, not for the lack of observation, but the lack of words to describe them. Some of James' learning cannot be represented in this study because representing it in words is impossible for me, which makes it even more important to understand that which we can about his experience.

References

Agran, M., Blanchard, C., Wehmeyer, M., & Hughes, C. (2001). Teaching students to self-regulate their behavior: The differential effects of student-vs. teacher-delivered reinforcement. *Research in Developmental Disabilities, 22*(4), 319–332. https://doi.org/10.1016/S0891-4222(01)00075-0

Apedoe, X. S., Ellefson, M. R., & Schunn, C. D. (2012). Learning together while designing: Does group size make a difference? *Journal of Science Education and Technology, 21*(1)*,* 83–94. https://doi.org/10.1007/s10956-011-9284-5

Bargerhuff, M. E. (2013). Meeting the needs of students with disabilities in a stem school. *American Secondary Education, 41*(3), 3–20. www.jstor.org/stable/43694164

Barrows, H. S. (1996). Problem-based learning in medicine and beyond: A brief overview. *New Directions for Teaching and Learning, 68,* 3–12. https://doi.org/10.1002/tl.37219966804

Beckett, G. H., Hemmings, A., Maltbie, C., Wright, K., Sherman, M., & Serison, B. (2016). Urban high school student engagement through CincySTEM iTEST projects. *Journal of Science Education and Technology, 25*(6)*,* 995–1007. https://www.learntechlib.org/p/193289/

Belland, B. R., Ertmer, P. A., & Simmons, K. D. (2006). Perceptions of the value of problem-based learning among students with special needs and their teachers. *Interdisciplinary Journal of Problem-Based Learning, 1*(2), 1–18. https://doi.org/10.7771/1541-5015.1024

Bennett, S. (2007). *That workshop book: New systems and structures for classrooms that read, write, and think.* Heinemann.

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palinscar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist, 26*(3–4), 369–398. https://doi.org/10.1080/00461520.1991.9653139

Boon, R. T., Fore. III, C., Ayres, K., & Spencer, V. G. (2005). The effects of cognitive organizers to facilitate content-area learning for students with mild disabilities: A pilot study. *Journal of Instructional Psychology, 32*(2)*,* 101–117. https://www.learntechlib.org/p/99811/

Boon, R. T., Fore III, C., Blankenship, T., & Chalk, J. (2007). Technology-based practices in social studies instruction for students with high-incidence disabilities: A review of the literature. *Journal of Special Education Technology, 22*(4), 41–56. https://doi.org/10.1177/016264340702200404

Boulden, W. T. (2008). Evaluation of the advancing young adult learning project. *Adult Basic Education and Literacy Journal, 2*(1), 3–12.

Brantlinger, E., Jimenez, R., Klinger, J., Pugasch, M., & Richardson, V. (2005). Qualitative studies in special education. *Exceptional Children, 71*(2), 195–207. https://doi.org/10.1177/001440290507100205

Bridgeland, J. M., Dilulio, J. J. Jr., & Morison, K. B. (2006). *The silent epidemic: Perspectives of high school dropouts.* https://docs.gatesfoundation.org/Documents/TheSilentEpidemic3-06FINAL.pdf

Capraro, R. M., Capraro, M. M., Scheurich, J. J., Jones, M., Morgan, J., Huggins, K. S., Sencer Corlu, M., Younes, R., & Han, S. (2016). Impact of sustained professional development in STEM on outcome measures in a diverse urban district. *The Journal*

of Educational Research, 109(2), 181–196. https://doi.org/10.1080/00220671.2014.936997

Carman, S. N., & Chapparo, C. J. (2012). Children who experience difficulties with learning: Mother and child perceptions of social competence. *Australian Occupational Therapy Journal, 59*(5), 339–346. https://doi.org/10.1111/j.1440-1630.2012.01034.x

Carpendale, J. I. M., Muller, U., & Bibok, M. B. (2008). Piaget's theory of cognitive development. In N. J Salkind (Ed.), *Encyclopedia of educational psychology, Vol. 2* (pp. 798-803). Sage.

Carr, T., & Jitendra, A. K. (2000). Using hypermedia and multimedia to promote project-based learning of at-risk high school students. *Intervention in School and Clinic, 36*(1), 40–44. https://doi.org/10.1177/105345120003600106

Chang, C. C., & Tseng, K.-H. (2011). Using a web-based portfolio assessment system to elevate project-based learning performances. *Interactive Learning Environments, 19*(3), 211–230. https://doi.org/10.1080/10494820902809063

Chang, L.-C., & Lee, G. C. (2010). A team-teaching model for practicing project-based learning in high school: Collaboration between computer and subject teachers. *Computers & Education, 55*(3), 961–969. https://doi.org/10.1016/j.compedu.2010.04.007

ChanLin, L.-J. (2008). Technology integration applied to project-based learning in science. *Innovations in Education and Teaching International, 45*(1), 55–65. https://doi.org/10.1080/14703290701757450

Cheng, R. W. Y., & Lam, S. T. (2008). When high achievers and low achievers work in the same group: The roles of group heterogeneity and processes in project-based learning.

British Journal of Educational Psychology, 78(2)*,* 205–221. https://doi.org/10.1348/000709907X218160

Civic Enterprises and John Hopkins University. (2015). *Building a grad nation: Progress and challenge in ending the high school dropout epidemic.* http://gradnation.americaspromise.org/sites/default/files/d8/18006_CE_BGN_Full_vFNL.pdf?_ga=1.93997467.740747157.1453930190

Culclasure, B. T., Longest, K. C., & Terry, T. M. (2019). Project-Based learning (Pjbl) in three southeastern public schools: Academic, behavioral, and social-emotional outcomes. *Interdisciplinary Journal of Problem-Based Learning, 13*(2). https://doi.org/10.7771/1541-5015.1842

Davidson, C. (2009). Transcription: Imperatives for qualitative research. *International Journal of Qualitative Methods, 8*(1), 1-52. https://doi.org/10.1177/160940690900800206

De La Paz, S., & Hernandez-Ramos, P. (2013). Technology-enhanced project-based learning: Effects on historical thinking. *Journal of Special Education Technology, 28*(4), 1–4. https://doi.org/10.1177/016264341302800401

Demirci, C. (2010). The project-based learning approach in a science lesson: A sample project study. *Cypriot Journal of Educational Sciences, 5*(1)*,* 66–79.

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process*. D.C. Heath & Co Publishers.

DuFon, M. A. (2002). Video recording in ethnographic SLA research: Some issues of validity in data collection. *Language Learning and Technology, 6*(1), 40-59. http;//dx.doi.org/10125/25142

Edmunds, J., Arshavsky, N., Glennie, E., Charles, K., & Rice, O. (2017). The relationship between project-based learning and rigor in STEM-focused high schools. *The Interdisciplinary Journal of Problem-based Learning, 11*(1). https://doi.org/10.7771/1541-5015.1618

Erdogan, N., Navruz, B., Younes, R., & Capraro, R. M. (2016). Viewing how STEM project-based learning influences students' science achievement through the implementation lens: A latent growth modeling. *Journal of Mathematics and Science & Technology Education, 12*(8)*,* 2139–2154. https://doi.org/10.12973/eurasia.2016.1294a

Ferretti, R. P., MacArthur, C. D., & Okolo, C. M. (2001). Teaching for historical understanding in inclusive classrooms. *Learning Disability Quarterly, 24*(1), 59–71. https://doi.org/10.2307/1511296

Filippatou, D., & Kaldi, S. (2010). The effectiveness of project-based learning on pupils with learning difficulties regarding academic performance, group work, and motivation. *International Journal of Special Education, 25*(1), 17–26.

Geier, R., Blumenfeld, P. C., Marx, R. W., Krajcik, J. S., Fishman, B., Soloway, E., & Clay-Chambers, J. (2008). Standardized test outcomes for students engaged in inquiry-based science curricula in the context of urban reform. *Journal of Research in Science Teaching, 45*(8)*,* 922–939. https://doi.org/10.1002/tea.20248

Gillies, R. M., & Ashman, A. F. (2000). The effects of cooperative learning on students with learning difficulties in the lower elementary school. *The Journal of Special Education, 34*(1), 19–27. https://doi.org/10.1177/002246690003400102

Glesne, C. (2016). *Becoming qualitative researchers: An introduction* (5th ed.). Pearson.

Guven, Y., & Duman, H. G. (2007). Project based learning for children with mild mental

disabilities. *International Journal of Special Education, 22*(1), 77–82.

Halvorsen, A. L., Duke, N. K., Brugar, K. A., Block, M. K., Strachan, S. L., Berka, M. B., & Brown, J. M. (2012). Narrowing the achievement gap in second-grade social studies and content area literacy: The promise of a project-based approach. *Theory & Research in Social Education, 40*(3), 198–229. https://doi.org/10.1080/00933104.2012.705954

Han, S., Capraro, R. M., & Capraro, M. M. (2016). How science, technology, engineering, and mathematics project based learning affects high need students. *Learning and Individual Differences, 51,* 157–166. https://doi.org/10.1016/j.lindif.2016.08.045

Harris, K. R., & Graham, S. (1994). Constructivism: Principles, paradigms, and integration. *The Journal of Special Education, 28*(3), 233–247. https://doi.org/10.1177/002246699402800301

Holmes, V. L., & Hwang, Y. (2016). Exploring the effects of project-based learning in secondary mathematics education. *The Journal of Educational Research, 109*(5)*,* 449–463. https://doi.org/10.1080/00220671.2014.979911

Hong, J. C., Chen, M.-Y., & Hwang, M.-Y. (2013). Vitalizing creative learning in science and technology through an extracurricular club: A perspective based on activity theory. *Thinking Skills and Creativity, 8*(1), 45–55. https://doi.org/10.1016/j.tsc.2012.06.001

Hovey, K. A., & Ferguson, S. L. (2014). Teacher perspectives and experiences: Using project-based learning with exceptional and diverse students. *Curriculum and Teaching Dialogue 16*(1/2), 77–90. https://ezproxy.library.ewu.edu/login?url=https://search.proquest.com/docview/15666

12772?accountid=7305.

Hsu, P.-S., Van Dyke, M., Chen, Y., & Smith, T. J. (2016). A cross-cultural study of the effect of a graph-oriented computer-assisted project-based learning environment on middle school students' science knowledge and argumentation skills. *Journal of Computer Assisted Learning, 32*(1), 51–76. https://doi.org/10.1111/jcal.12118

Hsu, P.-S., Van Dyke, M., Chen, Y., & Smith, T. J. (2015). The effect of graph-oriented computer-assisted project-based learning environment on argumentation skills. *Journal of Computer Assisted Learning, 31*(1), 32–58. https://doi.org/10.1111/jcal.12080

Hugerat, M. (2016). How teaching science using project-based learning strategies affects the classroom learning environment. *Learning Environments Research, 19*(3)*,* 383–395. https://doi.org/10.1007/s10984-016-9212-y

Individuals with Disabilities Education Act, 20 U.S.C. Sec. 1400 et seq. (2007).

Jimenez, T. C., Graf, V. L., & Rose, E. (2007). Gaining access to general education: The promise of universal design for learning. *Issues in Teacher Education, 16*(2), 41-54. http://caddogap.com/periodicals.shtml

Kafai, Y., & Resnick, M. (1996). Introduction. In Y. Kafai & M. Resnick (Eds.), *Constructionism in practice: Designing, thinking, and learning in a digital world* (pp. 1–8). Routledge.

Kaldi, S., Filippatou, D., & Govaris, C. (2011). Project-based learning in primary schools: Effects on pupils' learning and attitudes. *Education, 39*(1), 35–47. https://doi.org/10.1080/03004270903179538

Kalyoncu, R., & Tepecik, A (2010). An application of project-based learning in an urban

project topic in the visual arts course in 8th classes of primary education. *Kuram ve Uygulamada Egitim Bilimleri, 10*(4)*,* 2409–2430. https://ezproxy.library.ewu.edu/login?url=https://search.proquest.com/docview/857523626?accountid=7305

Katsanos, C., Tselios, N., Tsakoumis, A., & Avouris, N. (2012). Learning about web accessibility: A project based tool-mediated approach. *Education and Information Technologies, 17*(1), 79–94. https://doi.org/10.1007/s10639-010-9145-5

Kieran, L., & Anderson, C. (2019). Connecting universal design for learning with culturally responsive teaching. *Education and Urban Society, 51*(9), 1202-1216. https://doi.org/10.1177.0013124518785012

Kilpatrick, W. H. (1929). *The project method, the use of the purposeful act in the educative process* (5th ed.). Teachers' College.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, *41*(2), 75–86. https://doi.org/10.1207/s15326985ep4102_1

Kleinert, H. L., Kennedy, S., & Kearns, J. F. (1999). The impact of alternative assessments: A statewide teacher survey. *The Journal of Special Education, 33*(2), 93–102. https://doi.org/10.1177/002246699903300203

Krajcik, J. S., Blumenfeld, P. C., Marx, R. W., & Soloway, E. (1994). A collaborative model for helping middle grade science teachers learn project-based instruction. *The Elementary School Journal, 94*(5)*,* 483–497. https://doi.org/10.1086/461779

Larmer, J., & Mergendoller, J. (2010). Seven essentials for project-based learning.

Educational Leadership, 68(1), 34–37.

Larmer, J., Ross, D., & Mergendoller, J. R. (2009). *PBL starter kit.* Buck Institute for Education.

Learning Disabilities Association of America (2018). *Core principles.* https://ldaamerica.org/core-principles-what-are-learning-disabilities/

Lee, C. I., & Tsai, F.-Y. (2004). Internet project-based learning environment: The effects of thinking styles on learning transfer. *Journal of Computer Assisted Learning, 20*(1)*,* 31–39. https://doi.org/10.1111/j.1365-2729.2004.00063.x

Lee, H., & Songer, N. B. (2003). Making authentic science accessible to students. *International Journal of Science Education, 25*(8)*,* 923–948. https://doi.org/10.1080/09500690305023

Liu, M, & Hsaio, Y. P. (2002). Middle school students as multimedia designers: A project-based learning approach. *Journal of Interactive Learning Research, 13*(4), 311–337. https://www.learntechlib.org/primary/p/9529/

Lou, S.-J., Tsai, H.-Y., Tseng, K.-H., & Shih, R.-C. (2014). Effects of implementing STEM-I project-based learning activities for female high school students. *International Journal of Distance Education Technologies, 12*(1), 52–73. https://doi.org/10.4018/ijdet.2014010104

Lu, J., & Law, W. Y. (2012). Understanding collaborative learning behavior from Moodle log data. *Interactive Learning Environments, 20*(5), 451–466. http://dx.doi.org/10.1080/10494820.2010.529817

Massey, A., & Burnard, S. (2006). “Here’s one I made earlier!” A qualitative report on creativity in a residential primary school for children with social, emotional and

behavioral difficulties. *Emotional and Behavioural Difficulties, 11*(2)*,* 121–133. https://doi.org/10.1080/13632750600619422

Mastropieri, M. A., & Scruggs, T. E. (1992). Science for students with disabilities. *Review of Educational Research, 62*(4), 341–377. https://doi.org/10.3102/00346543062004377

Mastropieri, M. A., Scruggs, T. E., & Magnusen, M. (1999). Activities-oriented science instruction for students with disabilities. *Learning Disability Quarterly, 22*(4), 240–249. https://doi.org/10.2307/1511258

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. Jossey-Bass.

Morales, T. M., Bang, E., & Andre, T. (2013). A one-year case study: Understanding the rich potential of project-based learning in a virtual reality class for high school students. *Journal of Science Education and Technology, 22*(5)*,* 791–806. http://dx.doi.org/10.1007/s10956-012-9431-7

National Center for Education Statistics. (2019). *Students with disabilities.* https://nces.ed.gov/fastfacts/display.asp?id=64

National Center for Special Education Research. (2011). *Post high school outcomes of young adults with disabilities up to eight years after high school*. (NCSER 2011-3005). U.S. Government Printing Office.

National Center on Universal Design for Learning. (2013). *What is UDL?* http://udlcenter.org/about udl/whatisudl

Office of Special Education and Rehabilitative Services. (2019). *41st annual report to congress on the implementation of the individuals with disabilities education act, 2019*. http://www.ed.gov/about/reports/annual/osep

O'Keeffe, S. B., & Medina, C. M. (2016). Nine strategies for helping middle school students weather the perfect storm of disability, diversity, and adolescence. *American Secondary Education, 44*(3), 72–87.

Okolo, C.M., Ferretti, R. P. (1998). Multimedia design projects in an inclusive social studies classroom "Sometimes people argue with words instead of fists". *Teaching Exceptional Children, 31*(1), 50-57. https://doi.org/10.1177/004005999803100107

Ozdener, N., & Ozcoban, T. (2004). A project-based learning model's effectiveness on computer-based courses and multiple intelligence theory. *Kuram ve Uygulamada Egitim Bilimleri, 4*(1)*,* 164–170.

Papert, S. (1993). *Mindstorms: Children, computers, and powerful ideas* (2nd ed.). Basic Books.

Papert, S. (1996). A word for learning. In Y. Kafai & M. Resnick (Eds.), *Constructionism in practice: Designing, thinking, and learning in a digital world* (pp. 9–24). Routledge.

Papert, S., & Harel, I. (1991). *Situating constructionism*. Ablex Publishing Corporation. http://www.papert.org/articles/SituatingConstructionism.html

Partnership for 21st Century Learning. (2008). *21st century skills, education, and competitiveness: A resource and policy guide.* http://www.p21.org/storage/documents/21st_century_skills_education_and_competitiveness_guide.pdf

Peterson, T. E. (2012). Constructivist pedagogy and symbolism: Vico, Cassirer, Piaget, Baetson. *Educational Philosophy and Theory, 44*(8)*,* 878–891. https://doi.org/10.1111/j.1469-5812.2011.00765.x

Petrucco, C. (2013). Fostering digital literacy between school and the local community:

Using service learning and project-based learning as a conceptual framework. *International Journal of Digital Literacy and Digital Competence, 4*(3), 10–18. https://doi.org/10.4018/ijdldc.2013070102

Prestidge, L. K., & Williams-Glaser, C. H. (2000). Authentic assessment: Employing appropriate tools for evaluating students' work in 21st century classrooms. *Intervention in School and Clinic, 35*(3), 178–182. https:doi.org/10.1177/105345120003500308

Rose, D. H., & Meyer, A. (2002). *Teaching every student in the digital age: Universal design for learning.* Association for Supervision and Curriculum Development.

Saldana, J. (2016). *The coding manual for qualitative researchers* (3rd ed.). Sage.

Scruggs, T. E. (1993). Reading versus doing: The relative effects of textbook-based and inquiry-oriented approaches to science learning in special education classrooms. *The Journal of Special Education, 27*(1), 1–15. https://doi.org/10.1177/002246699302700101

Scruggs, T. E., Mastropieri, M. A., Berkeley, S., & Graetz, J. E. (2010). Do special education interventions improve learning of secondary content: A meta-analysis. *Remedial and Special Education, 31*(1), 437–449. https://doi.org/10.1177/0741932508327465

Seet, L. Y. B., & Quek, C. L. (2010). Evaluating students' perceptions and attitudes toward computer-mediated project-based learning environment: A case study. *Learning Environments Research, 13,* 173–185. https://doi.org/10.1007/s10984-010-9073-8

Smith, S. (2016). (Re)counting meaningful learning experiences: Using student-created reflective videos to make invisible learning visible during PjBL experiences. *The Interdisciplinary Journal of Problem-based Learning, 10*(1).

https://doi.org/10.7771/1541-5015.1541

Stone, J. R., Alfeld, C., & Pearson, D. (2008). Rigor and relevance: Enhancing high school students' math skills through career and technical education. *American Educational Research Journal, 45*(3), 767–795. https://doi.org/10.3102/0002831208317460

Summers, E. J., & Dickinson, G. (2012). A longitudinal investigation of project-based instruction and student achievement in high school social studies. *The Interdisciplinary Journal of Problem-Based Learning, 6*(1), 82–103. https://doi.org/10.7771/1541-5015.1313

Svihla, V., Kubik, Stephens-Shauger, T. (2019). Performance assessment practice as professional learning. *Interdisciplinary Journal of Problem-Based Learning, 13*(2). https://doi.org/10.7771/1541-5015.1812

Swanson, H. L., (2001). Searching for the best model for instructing students with learning disabilities. *Focus on Exceptional Children, 34*(2), 1-16. https://doi.org/34.10.17161/foec.v34i2.6785

Swanson, H. L. (1999). Instructional components that predict treatment outcomes for students with learning disabilities: Support for a combined strategy and direct instruction model. *Learning Disabilities Research and Practice, 14*(3), 129-140. https://doi.org/10.1207/sldrp1403_1

The Association for the Severely Handicapped. (2016). *Inclusive education.* http://tash.org/advocacy-issues/inclusive-education/

Thompson. S. J., Quenemoen, R. F., & Thurlow, M. L. (2003). The status of large-scale assessment practices for students with disabilities in rural America. *Rural Special Education Quarterly, 22*(4), 3–9. https://doi.org/10.1177/875687050302200402

Tomlinson, C. A. (1999). Mapping a route toward differentiated instruction. *Educational Leadership, 57*(1)*,* 12–16. http://pdonline.ascd.org/pd_online/diffinstr/el199909_tomlinson.html

Tomlinson, C. A., Brighton, C., Hertberg, H., Callahan, C. M., Moon, T. R., Brimijoin, K., Conover, L. A., & Reynolds, T. (2003). Differentiating instruction in response to student readiness, interest, and learning profile in academically diverse classrooms: A review of the literature. *Journal for the Education of the Gifted, 27*(2–3), 119–145. https://doi.org/10.1177/016235320302700203

Tsai, C.-W., Shen, P.-D., & Lin, R.-A. (2015). Exploring the effects of student-centered project-based learning with initiation on students' computing skills: A quasi-experimental study of digital storytelling. *International Journal of Information and Communication Technology Education, 11*(1)*,* 27–43. https://doi.org/10.4018/ijicte.2015010102

Turnbull, H. R., Stowe, M. J., & Huerta, N. E. (2007). *Free appropriate public education* (7th ed.). Love Publishing.

U.S. Department of Labor. (1991). *Secretary's commission on achieving necessary skills: What work requires of schools.* https://wdr.doleta.gov/scans/whatwork/whatwork.pdf

von Glasersfeld, E. (1984). An introduction to radical constructivism*.* In P. Watzalawick (Ed.), *The invented reality* (pp. 17–40). Norton and Company. http://www.univie.ac.at/constructivism/EvG/papers/070.1.pdf

von Glasersfeld, E. (1989). Cognition, construction of knowledge, and teaching. *Synthese, 80*(1), 121–140. www.jstor.org/stable/20116670

Vygotsky, L. S. (1994a). The problem of the environment. In R. Vand Der Veer & J. Valsiner (Eds.) & T. Prout (Trans.), *The Vygotsky reader* (pp. 338–354). Blackwell.

Vygotsky, L. S. (1994b). The development of thinking and concept formation in adolescence. In R. Vand Der Veer, & J. Valsiner (Eds.) & T. Prout (Trans.), *The Vygotsky reader* (pp. 185–265). Blackwell.

Vygotsky, L. S., & Luria, A. (1994). Tool and symbol in child development. In R. Vand Der Veer, & J. Valsiner (Eds.) & T. Prout (Trans.), *The Vygotsky reader* (pp. 99–175). Blackwell.

Wang, H.-Y., Huang, I., & Hwang, G.-J. (2016). Effects of a question prompt-based concept mapping approach on students' learning achievements, attitudes, and 5C competencies in project-based computer course activities. *Journal of Educational Technology & Society, 19*(3)*,* 351–364. https://www.jstor.org/stable/jeductechsoci.19.3.351

Wuttisela, K., Wuttiprom, S., Phonchaiya, S., & Saengsuwan, S. (2016). Implementation of online peer assessment in a Design for Learning and Portfolio (D4L+P) program to help students complete science projects. *The Turkish Online Journal of Educational Technology, 15*(4), 69–76. https://ezproxy.library.ewu.edu/login?url=https://search.proquest.com/docview/1862680491?accountid=7305

Yin, R. K. (2013). *Case study research: Design and methods* (5th ed.)*.* Sage Publications.

Zusevics, K. L., & Johnson, S. (2014). Does hope change? Testing a project-based health intervention among students of color. *The Urban Review, 46,* 268–291. https://doi.org/10.1007%2Fs11256-013-0263-4

APPENDICES

Appendix A

Research Activities and Data Sources to Address Research Questions

Question	
How do students with disabilities experience PBL in relation to their supports and interactions with instructional activities; materials and tools; and instructors and fellow students?	
Subquestions	Method for answering
What components of PBL are present in the classroom	Observation; teacher interviews; targeted questioning
how does the learning environment scaffold learning for students with disabilities in PBL?	Observations; targeted questioning; artifact analysis
How do students navigate learning in the PBL environment (i.e., how are students interacting with learning materials and activities to learn and how are they interacting with teachers and peers in learning project content and skills)??	Observations; targeted questioning; student interviews
How do students demonstrate their learning in the PBL environment?	Observations; artifact analysis; student interviews; teacher interviews

Appendix B

Interview Questions for Students

Pre Interview Questions

How long have you been at this school?

Where did you go to school before you came to HHS?

Tell me about the ways that the teachers taught in your old school?

- What were the kinds of assignments that you did in your class?
- Did the teacher mostly talk, did you mostly do individual work, do group work?
- What experiences have you had doing projects before coming to HHS?

What do you know about Project-Based Learning?

Compare this way of learning to learning that you did in your old school. What is similar?

What is different?

Tell me about a project that really stands out to you.

Describe a typical day in your project.

- Why did you pick that project?
- What made it memorable for you?
- How did you get your work done?
- What do you do if you get stuck?
- How did you know that you have learned something at the end of the project?
- Tell me about working in a small group in that project?
- How do you decide who to work with in projects?
  - What made a good partner in that project?

What made you a good partner in that project?

What made a/you bad partner in that project?

What did the teachers do to help you/keep you from learn(ing)?

What choices did the teachers give you in that project?

What have you learned in your projects that you have done that helps you in other places?

What is the best way to show that you learned something in the project?

What advice would you give a new student about learning in projects at HHS?

Is there a teacher I should talk to in order to better understand what is helpful to you?

Tell me about a project that you wish you had been a student in.

Is there anything else you want to tell me about working in projects?

Post Interview Questions

So just for a refresher, can you tell me what this last project was about?

What was the driving question?

What kinds of things did you do in the class to answer the driving question?

What content did you learn that helped you?

How did this project connect to other classes you have taken?

What was the most challenging part of this class?

What was the easiest part of this class?

Do you think you did good work in the class?

What did that look like?

Who helped you get your work done?

What did X do to help you get your work done?

Who didn't help you get your work done?

What did X do or not do to help you with your work?

Appendix C

Interview Questions for Teachers

What is your understanding of how to make Project-Based Learning work in a classroom?

What has your experience been using PBL curriculum?

What components in PBL help students?

What components in PBL do not help students?

Describe a typical day in your project.

How can you tell if a student needs help?

How do you help students with disabilities in the project?

How do you get students to problem solve independently in a project? As a group?

What makes for a good experience for students in a project?

Tell me about a project that stands out to you.

How do you define success in a project?

Tell me about a project that was really meaningful to you/learned a lot from?

What is your process for understanding what a student needs to succeed in your project?

Appendix D

Observation Tool

<table>
<tr><td colspan="2">Date: # students present: Topic:

Location: Recording:
Class Out CL DL B Other Aud Vid Obs</td><td rowspan="2">Component analysis:
☐Need to Know
☐21 Cent. Skills
☐Driving Question
☐Voice and Choice
☐Inquiry and Innovation
☐Feedback and Revision
☐Present to Public Audience
Notes:</td><td rowspan="2">Focus of Observation:

Notes:</td></tr>
<tr><td colspan="2">Classroom layout: (focals noted)</td></tr>
<tr><td>Interactions w/focal:
T/S F/T F/S S/F

F/O O/F
Notes:</td><td>Interactions w/focal:
T/S F/T F/S S/F

F/O O/F
Notes:</td><td>Interactions w/focal:
T/S F/T F/S S/F

F/O O/F
Notes:</td><td>Interactions w/focal:
T/S F/T F/S S/F

F/O O/F
Notes:</td></tr>
</table>

Class (classroom); Out (outside); CL (clean lab); DL (dirty lab) B (back patio); O (other)
T (teacher); F (focal); S (student); O (other)
Aud (audio); Vid (video); Obs (direct observation)

Appendix E

Transcription Key

- All intelligible words are transcribed exactly as they are heard in the audio.
    - Grammar / pronunciation not 'cleaned up' or changed. For example, if someone says "gonna", it is transcribed "gonna", not "going to".
- XX indicates an unintelligible utterance.
- A period . indicates 'phrase-final' falling intonation.
- A question mark ? indicates rising intonation.
- A comma , indicates a pause.
- A dash indicates that a word was not fully pronounced. For example, "y- yeah" would indicate that someone started to say "yeah" but only started it, then said it again.
- Square brackets [ ] indicate speaker overlap. The words between brackets represent the words that were spoken by two or more speakers simultaneously.
- Equals signs = indicate that there is no pause between speakers (ie. a speaker is talking when another speaker interjects, without overlap)
- Double parentheses (( )) indicate extralinguistic parts of the audio, such as beeps or slams
- A colon : indicates that a sound is lengthened more than usual
- A word in all caps indicates that the word was produced with pronounced emphasis
- Double slashes // indicate a break in the recording

Appendix F

Code Tree

Theme	Subtheme	Parent Code	Child Code
Supporting students	Direct Support	Supporting Students	Individualization
		Positive Tone of Interaction	
		Supporting Students	Students as Coaches
			Feedback
		Supporting Students	Students' Tool Use
		Supporting Students	Teaching Academic Skills
		Supporting Students	Small Group work
		Supporting Students	Coach Students Through Every Moment
		Supporting Students	
	Indirect Support	Plan for Connections	Teachers Knowing Connections
		Supporting Students	Knowing Students
		Supporting Students	Balancing Workload
		Supporting Students	Routines
		There's a Point to Instruction	
		Flexibility in Instruction	
Student Buy-in	Personal Relevance	Student Buy-in	Personal Relevance
		Students Value Class Experience	Interest

Theme	Subtheme	Parent Code	Child Code
	Engagement	Indicators of Effective PBL Instruction	Engagement
		Indicators of Effective PBL Instruction	Student Persistence and Effort
		What Makes a Good Worker	
	Pride in Work	Pride in Work	
PBL is Complex	Responsive to Student Needs	Supporting Students	Negotiated Support
	Challenges	Teacher Comfort with PBL Instruction	Teachers Learning with Students
Student Demonstration of Learning	Synthesis	Indicators of Effective PBL Instruction	Synthesizing
	Growth in Skills and Knowledge	Indicators of Effective PBL Instruction	Growth in Skills and Knowledge

Appendix G

Tool given to Students for final PowerPoint

Final Exhibition

Final Exhibition Slides Outline Product guiding doc

Mistakes in Architecture

	Information on Slide	Information Shared Verbally (You may use note cards!)
Slide 1	• Mistakes in Architecture • Name • Years at Henry	Same as slide
Slide 2	• Slide Title: **Name of your final exhibition building** • Photo of your final exhibition building • Slide Details: When your mistake took place	Same as slide
Slide 3	• Image of **Coggle** (Ms. Beth can help you upload it into your presentation)	Use your Coggle to verbally explain the story of your building's mistake.
Slide 4	• Slide Title: **Design/Build Process**	Briefly say that you will be describing where these mistakes took place in the design/build process of the building.
Slide 5	• Slide Title: **Feasibility Study** • Slide Details: Short bullet points describing what part of the mistake happened in this section of the design/build process • Applicable Picture	Verbally explain your bullet points with more detail
Slide 6	• Slide Title: **Concept** • Slide Details: Short bullet points describing what part of the mistake happened in this section of the design/build process • Applicable Picture	Verbally explain your bullet points with more detail
Slide 7	• Slide Title: **Detailed Scope** • Slide Details: Short bullet points describing what part of the mistake happened in this section of the design/build process • Applicable Picture	Verbally explain your bullet points with more detail
Slide 8	• Slide Title: **Detailed Design (Engineering)** • Slide Details: Short bullet points describing what part of the mistake happened in this section of the design/build process • Applicable Picture	Verbally explain your bullet points with more detail

Slide 9	• Slide Title: **Procurement** • Slide Details: Short bullet points describing what part of the mistake happened in this section of the design/build process • Applicable Picture	Verbally explain your bullet points with more detail
Slide 10	• Slide Title: **Construction** • Slide Details: Short bullet points describing what part of the mistake happened in this section of the design/build process • Applicable Picture	Verbally explain your bullet points with more detail
Slide 11	• Slide Title: **Commissioning & Startup** • Slide Details: Short bullet points describing what part of the mistake happened in this section of the design/build process • Applicable Picture	Verbally explain your bullet points with more detail
Slide 12	• Slide Title: **Project Closeout** • Slide Details: Short bullet points describing what part of the mistake happened in this section of the design/build process • Applicable Picture	Verbally explain your bullet points with more detail
Slide 13	• Slide Title: **Driving Question** • Slide Details: How do design, communication, and execution impact the success of a commercial building?	"Our driving question for this project is..."
Slide 14	• Slide Title: **Design** • Slide Details: Short bullet points describing what part of the mistake were a design issue • Applicable Picture	Verbally explain your bullet points with more detail
Slide 15	• Slide Title: **Communication** • Slide Details: Short bullet points describing what part of the mistake were a communication issue • Applicable Picture	Verbally explain your bullet points with more detail
Slide 16	• Slide Title: **Execution** • Slide Details: Short bullet points describing what part of the mistake were an execution issue • Applicable Picture	Verbally explain your bullet points with more detail
Slide 17	• Slide Title: **Questions**	Ask the audience if they have any questions
Slide 18	• Slide Title: **Thank you**	Say thank you to your audience

Appendix H

Mind Map Instructions

How to Use Mind Maps for Problem Solving

Mind ma resourc

In this article, we discover how Mind Maps can help you when you are problem solving, whether in the office, at home or in the classroom.

Why is problem solving important?

Problem solving is a key skill which can help you succeed. Problems or obstacles occur all the time, and it is important that you can provide quick and imaginative solutions to them. Being able to problem solve is one of the major attributes looked for by universities and employers, as it displays both logical and creative thinking.

What do Mind Maps have to do with it?

Using Mind Maps can help to bypass the usual panic instinct of the brain when confronted with a problem to solve. When faced with a problem, we automatically panic, with symptoms of 'intense fear, a racing heart, breathlessness and trembling', according to the New Scientist. Not ideal for getting into a problem solving frame of mind!

Instead of 'forcing' your mind to come up with a solution, which can result in stress, Mind Mapping opens up possibilities and calms you. When you Mind Map for problem solving, you instantly gain more clarity, so you can find answers more easily. You view the problem as a positive challenge and an opportunity to show off your creative skills!

What are the benefits of Mind Maps for problem solving?

Mind Maps contain all the elements of your problem in one visual 'take'. Here's why they are so useful for problem solving:

Mind Maps prioritise the most important aspects of your problem, focusing your mind.

The use of colours and images stimulate your brain, meaning that you are engaged and ready to solve the problem.

https://imindmap.com/articles/how-to-use-mind-maps-for-problem-solving/

Appendix I

Student Example of Mind Map for Ray and Maria Building