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Probe Method's Impact on Students' Motivation and Critical Thinking Skills

Diane Marie Specht
Walden University

Walden University

College of Education

This is to certify that the doctoral dissertation by

Diane Specht

has been found to be complete and satisfactory in all respects,
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the review committee have been made.

Review Committee
Dr. Heng-Yu Ku, Committee Chairperson, Education Faculty
Dr. Kathleen Lynch, Committee Member, Education Faculty
Dr. Kathleen Foley-Peres, University Reviewer, Education Faculty

Chief Academic Officer
Eric Riedel, Ph.D.

Walden University
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Abstract

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Diane M. Specht

M.S., Walden University, 2004

B.A., University of West Florida, 1992

Dissertation Submitted in Partial Fulfillment

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Educational Technology

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Abstract

The probe method (PM) is a learning model that equips students with essential learning strategies and skills so they can be successful and competitive in a highly diverse technological global workforce. Although research indicates this learning model was successful at the elementary school level with improving students' motivation to learn, their critical thinking skills, and their ability to solve complex problems, little research has examined the impact of this method at the high school level for students who participated in a career and technical education (CTE) program. The purpose of this qualitative case study was to fill a gap in knowledge about the role and function of the PM on high school students' motivation to learn and their critical thinking skills in a CTE program. Guided by the conceptual framework of constructivism, data were collected through surveys, reflective journals, interviews with 17 students, and a teacher interview. Data were analyzed through descriptive and content analysis using open coding to determine what active learning was taking place, whether authentic project-based and problem-based learning strategies were implemented, and what 21st century workforce skills were being taught. Findings indicated that the PM had a positive impact on high school students' motivation to learn and their ability to think critically in a CTE program. This study supports positive social change by providing high school CTE teachers with a valuable learning model that infuses reflective thought, collaboration, communication, problem solving, and critical thinking into the learning process while at the same time motivating students to learn.

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Dedication

I would like to dedicate my dissertation to my mother and father, James and Carole Specht. Even though my father is no longer here, his spiritual presence is always pushing me to accomplish my goals. He was a fabulous father and wonderful individual who had an unwavering zest for life. My mother has been my spirited cheerleader and has provided me the inspiration to keep going when I thought I could not write another word. I cannot thank her enough for being there through my entire Ph.D. degree process. Achieving this degree is a testament that parents are critical to the success of their children because without my mother taking the additional time to work with me as a child who struggled to learn how to read, write, and spell, I would not have made it this far in my educational pursuits.

I also want to dedicate this dissertation to my sisters, Marcy, Mary Ellen, and Jamie who have been my additional cheerleaders and my brother, Joe and wife Kerrie, who provided the laughs and comments of inspirations to keep my goal in sight. Marcy, I could not say thank you enough for the many hours of conversation as we both were going through our degree programs. You are definitely my kindred spirit. Mary Ellen, thank you for the deepest belief that I would reach my goal. Jamie, I cannot express how thankful I am to have you as my little sister and for your patience on teaching me how to write during our college years. Also, I dedicate this dissertation to Marcy's husband, Max, who has been a fabulous brother-in-law and has served in the military for over 30 years. I have the deepest amount of admiration for Max because of his profound love for Marcy, family, and country.

Additionally, I want to dedicate this dissertation to my nieces Tiffany, Heather, Sara, Ashley, Katie, Sissy (and husband Caleb), Amber, Jody, and Mackenzie as well as nephews Nathan (and wife Jessica), Jared (and wife Taylor), and Austin. Also, I dedicate this dissertation to my great nephews Liam, Logan, Landon, and Noah as well as great nieces Alexa and Haylee. They have provided my life with an enormous amount of love and have provided me many hours of laughter and inspiration when I needed it the most.

I dedicate this dissertation to my nephew Jared because he is a true hero and an inspiration to me. Jared has served his country for eight years and has been instrumental in assisting the families of wounded warriors. Also, I dedicate this dissertation to my nephew Nathan who served his country for four years and inspires me with his determination to achieve his goals and dreams. Additionally, I dedicate this dissertation to Tiffany's husband Josh who has served in the military for 20 years and is an inspiration to me because of his love for learning as well as his dedication to family and country.

The final dedication of this dissertation goes to Della McCaughan. As an educator for 44 years in Biloxi, Mississippi, I did not have the honor of having Della as my teacher. However, I have had the honor to have her as a friend and mentor. It was Della who encouraged me to pursue my Ph.D. degree and she has provided me the utmost guidance and professional wisdom needed to complete my educational goal of higher education. Della is a person who has dedicated her life to inspiring others to learn. I say a special heartfelt thank you to Della for being my devoted mentor, but most of all, my friend.

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Chapter 1: Introduction to the Study

Introduction

The American College Testing (ACT) test is a standardized test that measures college and career readiness, and high school achievement; it is often used for college entrance requirements (ACT, 2013). The ACT test confirmed that through data collected from students who took the ACT test in 2012, most graduating American students are not prepared for higher education nor for the workforce (ACT, 2013). Only 26%, or 1 out of 4, of the 1.8 million graduates from American schools who took the ACT test in 2013 met all four benchmarks (i.e., English, Science, Mathematics, and Reading) and thus were ready for either college or a career (ACT, 2013). These results indicate that many members of the graduating class of 2013 are not prepared for higher education and/or the challenges of the workforce. Thus, there is a major concern for educators, administrators, legislators, and parents that the educational system in America is not meeting its goal of providing high-quality of education for all members of its citizenry (ACT, 2013).

According to the U.S. Department of Education, Office of Planning, Evaluation and Policy Development (2010), 40% of high school graduates have to take remedial classes while attending college and many employers report that high school graduates are underprepared as well as lack basic skills for the workforce. This is the concern of the U.S. Department of Education (2010) about students' lack of college and career readiness. Consequently, getting students prepared for higher learning is critical to the success of high schools; educators at the high school level need learning models that will

bring rigor and higher order thinking skills back into the learning process of high school students (Liang, 2012).

In this qualitative case study, I explored the role and function of the probe method (PM) as an instructional model for addressing high school students' motivation to learn and critical thinking skills among those who participated in a career and technical (CTE) program. This study is expected to contribute to the body of knowledge needed to address the problem of a lack of research on the PM learning model (Shepherd, 1998). Furthermore, this study explored how the PM impacts high school students' motivation to learn and their critical thinking skills when implemented in a CTE program.

Background

The rapid advancement of technology has created unprecedented transformations in society (O'Bannon & Thomas, 2014). It is through these technological advancements and societal transformations that have placed new burdens on the American educational system. One obstacle impeding academia is how to educate technologically savvy students about the needs of the 21st century (O'Bannon & Thomas, 2014).

Since society's transformations have been moving in parallel with technological advancements, it is reasonable that school reform should be in alignment with both technological advancements and societal transformations to ensure equilibrium among the three components. This current lack of alignment creates tension between academia's expectations of students versus society's expectation of its workforce and citizenry (O'Sullivan & Dallas, 2010; Symond, 2012). This imbalance has placed limitations on many crucial areas of cognitive development that results in students being ill-prepared for

advancement to the next level of training (i.e., college, technical school, or workforce) or for becoming highly skilled, knowledgeable, and productive citizens (O'Sullivan & Dallas, 2010; Symond, 2012).

The U.S. Department of Labor, Bureau of Labor Statistics (2013) revealed that in a 12 month period 370,000 students dropped out of high school. This high number indicates that students are not motivated to finish their high school education. Further data provided by the U.S. Department of Labor, Bureau of Labor Statistics (2013) stated that "of the 3.2 million youth age 16 to 24 who graduated from high school between January and October 2012, about 2.1 million (66.2%) were enrolled in college in October" (p. 1). Comparing the college enrollment of October 2011 (68.3%) and October 2012 (66.2 %), there has been a decrease in students attending college (U.S. Department of Labor, Bureau of Labor Statistics, 2013, p. 1). This is not a positive trend for the American educational system or the American economy.

The pressure to increase student's motivation to learn while increasing their cognitive development with fewer resources is a dilemma many school districts have to face on a daily basis. CTE programs are educational programs that offer students the opportunity to develop specific trade skills sought in the workforce and are often overlooked programs for cognitive development. Over the years, CTE has gone by numerous titles (i.e., vo-tech, vocational-technical education, or electives); however, the purpose of the program has not wavered over the years: to ensure that students develop career skills and specific trade skills (U.S. Department of Education, 2006). According to the U.S. Department of Education, Office of Vocational and Adult Education (OVAE;

2012), CTE programs provide students opportunities to problem solve, practice leadership skills, work collaboratively with others, experience how an organization functions on a daily basis, and develop perseverance and patience when issues occur. CTE programs offer real-world experiences in learning environments that are based on hands-on learning.

The technological advancements of the 21st century has educators focusing on their attention on CTE programs (OVAE, 2012). CTE programs in the United States have been funded by the Carl D. Perkins Vocational and Technical Education Act of 2006. Its purpose is to provide trade skills while merging academic learning into the curriculum of CTE courses (U.S. Department of Education, S.2. Purpose, 2006). The goal of the Carl D. Perkins Vocational and Technical Education Act of 2006 is to teach trade skills to students so that they acquire the skills needed to become highly skilled members of the global work force (U.S. Department of Education, 2006). CTE programs give students real-world experience within the learning environment of academia. But there are obstacles that hinder many CTE programs from maximized teaching of skills and knowledge.

The structure of the high school curriculum is one area of concern. Fletcher and Zirkle (2009) summarized the high school curriculum structure by explaining that there are four possible graduation options (i.e., general, college prep, CTE, or dual) offered to United States high school students. There are school districts that offer only a college-prep, a general, or a CTE track while others are offer a dual track that embraces both college-prep and CTE tracks (Symonds, 2012). Limiting students to one track has proven

an ineffective method for getting high school students to become ready college and career. Symonds (2012) emphasized that high schools across the United States encourages students to seek a four year degree which limits isolates many students from pursuing other career and educational options. Similar to Symonds' concern about how the high school curriculum track needs to shift to a dual track, Halpern (2012) expressed the importance of a dual track because students are given the opportunity to gain experiences that expose high school students to the rigor and demands of real-world experiences. Encouraging school districts to merge academic classes built around CTE classes that offer apprenticeships with local community members creates a rich learning environment. By doing this, students are given a multitude of experiences while developing trade skills. Halpern (2012) explained that CTE courses allow students to gain a variety of skills and learning experiences. Students who take CTE classes are provided the knowledge of different career fields, therefore, they are able to make wise career and higher educational decisions. However, these diverse real-world experiences and career decisions can only be achieved if students are given the opportunity to have CTE programs aligned with academic courses.

This position is supported by the work of Fletcher and Zirkle (2009), who found through their ex post facto research study that students who took a dual track high school curriculum were more likely to attain a high school degree as well as an associate degree than any other track option. The researchers also reported that a CTE track completer (i.e., two or more CTE classes) was more likely to complete high school compared to a college-prep or general track student. A CTE track completer had the highest earned

income average, whereas a dual-track completer came in second compared to the general and college-prep student. Also noted in Fletcher and Zirkle's study was the fact that students who completed a dual track appeared to be combining academic knowledge from the college-prep track with career trade skills to enhance their college and career readiness. Even though the dual track ranked third in attaining a bachelor's degree compared to the other tracks, success in high school and 2 years of college placed these students on a successful pathway for college and career readiness (Fletcher & Zirkle, 2009).

Since society demands college- and career-prepared high school graduates, many states are starting to participate in "CTE programs [that] are organized by 16 Career Clusters and 79 Career Pathways" (National Association of State Directors of Career and Technical Education [NASDCTE], CTE At-a-Glance, 2013). States that are making these changes are following the request put forth in the Carl D. Perkins Act of 2006 which focused on national reform of CTE programs. The Carl D. Perkins Act of 2006 proposed that CTE reform is needed so that secondary education can offer various types of CTE courses whether in the format of career clusters, career academies, or through distance learning. This type of CTE reform will supply the workforce with highly educated and skilled workers because students will be able to achieve trade skills along with their academic education (U.S. Department of Education, 2006). The pendulum for high school reform has begun moving toward the career cluster framework which merges CTE courses with academic education.

Embracing CTE courses into the curriculum has become perplexing to many educational leaders because the traditional educational models separate CTE courses from academic courses. Fletcher and Zirkle (2009) explained that educational leaders are having to restructure their curriculum to bridge and maximize the benefits of both academic and CTE classes. According to Fletcher and Zirkle, students who participated in a dual-track high school curriculum achieved success because they used skills from both areas. High school academic courses tend to integrate more learning strategies on how to solve complex problems and think critically, whereas CTE courses tend to integrate learning strategies that incorporate real-world issues and skills into the learning environment (Fletcher & Zirkle, 2009; Halpern, 2012). Consequently, CTE programs need learning models that promote motivation, critical thinking, and problem solving of complex issues so that students are prepared for the rigor of the 21st century workforce, whether they follow a high school curriculum CTE track or a dual track.

Problem Statement

In the last decade, drastic changes in technological innovations have occurred; they have placed strain on and have challenged the educational systems of the world. Students of the 21st century must have the skills to be able to engage in higher-order thinking to use, analyze, and synthesize information. Johansen, Scaff, and Hargis (2009) recognized that students need to know how to communicate, problem solve, and make decisions while working in an atmosphere of diverse individuals. Training students to be productive members of the workforce is a goal sought in education; however, educational institutions are not achieving this goal (U.S. Department of Education, 2010).

Consequently, education has to reform programs, curriculum standards, methodologies, and learning models to meet the demands of a new generation of technological savvy students who need to learn how to be motivated learners, proficient critical thinkers, and solvers of complex problems.

The problem addressed in this case study is the fact that high school students in CTE programs are taught trade and soft skills (e.g., professionalism, communication, problem-solving, etc.), but lack instructional opportunities that motivate them to learn and to think critically. This study contributes to the body of knowledge needed to address this problem by exploring a learning model called the PM (Shepherd, 1998), which was designed to enhance students' critical thinking abilities, provide opportunities to tackle complex real-world problems, and guide students to be self-directed learners while creating a positive collaborative learning environment (see Appendix A).

Purpose of the Study

The purpose of this qualitative case study was to explore the role and function of the PM (Shepherd, 1998) as an instructional model for addressing both motivation to learn and critical thinking among high school students in a CTE program. Insights from researching the PM in a high school CTE program should provide a valuable learning model that improves students' knowledge and understanding, engages students in their learning process, and provides students with learning opportunities to develop critical thinking skills for complex issues. There is a significant shortage in researched learning models that help engage students and develop critical thinking skills in CTE programs at the high school level. Supplying the educational pipeline with a researched learning

model that improves 21st century skills is highly beneficial for students and the success of the American educational system.

The goal of this study was to explore positive social change by increasing motivation to learn and developing critical thinking skills of high school students in a CTE program using the PM learning model (Shepherd, 1998). By giving educators a learning model that develops a zest for learning and promotes critical thinking in a constructivist, project-based learning environment, students may be able to effect positive social change by learning to think critically. Being able to think critically is a skill that is needed to prosper in a highly dynamic, global society.

Nature of the Study

This qualitative, single case study included interviews, surveys, and journals within a high school CTE classroom. Leedy and Ormrod (2005) defined a case study as a single unit of analysis that occurs over a specific period of time. Stake (1995) highlighted the fact that "a case study is expected to catch the complexity of a single case" (p. xi). One teacher and approximately 17 students implemented the PM (Shepherd, 1998). Taking the PM as a particular instructional method, this study explored the complexity of the PM; as such, it was "intrinsically bounded" (Merriam, 2009, p. 41). An intrinsically bounded case study is a study of an important single unit. The PM is a single phenomenon that was studied in its real-world context for a defined period of time; a limited number of people were interviewed and surveyed (Merriam, 2009; Yin, 2012).

Research Questions

1. How does the PM impact high school students' motivation to learn when implemented in a CTE program?
2. How does the PM impact high school students' critical thinking skills when implemented in a CTE program?
3. How does the teacher perceive the PM as a means to motivate students to learn in a high school CTE program?
4. How does the teacher perceive the PM as a means to engage student in critical thinking skills in a high school CTE program?

Conceptual Framework

The conceptual framework for this study included the constructivist paradigm—the framework for 21st century learning (Partnership for 21st Century Learning, 2014)—and the project-based and problem-based learning strategies, both of which are structural components of the PM (Shepherd, 1998). The PM structure allows students to develop skills essential to 21st century learners, which include critical thinking, solving complex problems, conducting effective and efficient research, working collaboratively in a team environment, as well as the motivation to learn. These skills appear in the constructivist paradigm where the learner is engaged in her learning, which promotes a broader and deeper understanding and knowledge of the concepts being taught (Dewey, 1920).

The constructivist paradigm is based on Dewey's theory of "learning by doing" (Dewey, 1920), whereby he is able to construct knowledge from his experiences . A constructivist learning environment allows students to employ a variety of learning styles

while working at their own pace. Since everyone learns differently, constructivism promotes students to construct their understanding and knowledge within their own learning style. Hence, there is an increase in motivation to learn, critical thinking, and retention of concepts instead of memorization and regurgitating of facts that are segments of concepts (Papert, 1980). Learning in a constructivist environment empowers the student to be in charge of her own learning.

Problem-based and project-based instructional strategies support the constructivist paradigm because students are active participants in their own learning process instead of passive learners receiving information for memorization. Also, project-based learning and problem-based learning are two distinct learning strategies that work cohesively in a constructivist learning environment. Project-based learning occurs when students are required to construct a project and problem-based learning occurs when students are presented with a problem to solve and they must research solutions to that problem. These two learning strategies are incorporated within the PM (Shepherd, 1998) which is unique to this learning model. Normally, a learning model will embrace only one of those learning strategies (Larmer, 2013).

The PM (Shepherd, 1998), while it has characteristics similar to other known instructional strategies (e.g., Odyssey of the Mind and Inquiry-based learning), brings problem-based and project-based learning together as subparts in an overall structure. As subparts, these two instructional strategies seesaw back and forth on a fulcrum of their two distinct frameworks until the students balances them using the components of both frameworks to achieve maximum knowledge and understanding of the problem.

The PM (Shepherd, 1998) is a learning system that activates in depth learning while seeking equilibrium among its subparts. The first subpart of the PM requires that the teacher leads a whole class discussion about a complex topic and the students are asked to define the problem. Within this section of the PM framework, project-based learning occurs because the students define the problem instead of being given a problem. They decide on the product that will be created to help solve the complex problem.

The second subpart of the PM occurs when the whole group is separated into smaller groups to conduct research, analyze the problem, and decide on a solution to the complex problem. During this section, problem-based learning occurs because the students are seeking solutions to the problem, working collaboratively, and communicating with the teacher about issues that might solve the problem.

The third subpart of the PM takes place when students find the solution to the complex problem and create a product that supports their solution. This section of the PM is the one that embraces project-based learning because students reflect on their solution to their problem by creating their product. This subpart allows for reflection and communication among team members and encourages in depth critical thinking to take place, thinking that draws heavily on the project-based learning framework.

The fourth and final subpart of the PM (Shepherd, 1998) occurs when the smaller groups meet as a whole group and members from the smaller groups provide their solutions. This is where the PM teeters on the fulcrum between disequilibrium to equilibrium between problem-based and project-based learning. Students have their solutions to the problem and have created a product that supports their solution; however,

the whole group tries to decide if the solution is correct and if any adjustments need to be made based on the data gathered and the results of the products. Equilibrium occurs within the PM framework when all of the students have agreed decide on the best overall solution to the complex problem which is supported by the knowledge and understanding gained from the research and the creation of the product. These steps replicate a real-world, 21st century working environment; it allows students to see that there are a variety of solutions to complex problems and that by working collaboratively as a whole group the best solution can be found.

There are numerous instructional strategies that appear to be same as the PM (Shepherd, 1998), however, with similarities come differences. It is these differences that separate many instructional strategies into two distinct instructional strategy frameworks (i.e., project-based learning or problem-based learning). Examination Odyssey of the Mind (2014) and inquiry-based learning highlights how the PM is similar to these instructional strategies but more importantly how the PM differs.

Whereas the PM (Shepherd, 1998) seeks equilibrium between project-based and problem-based learning frameworks, the Odyssey of the Mind (Creative Competitions, Inc., 2014) leans toward the problem-based framework. In a project-based framework the product that is designed and created is summative of the analysis of the researched done to solve the problem. However, in Odyssey of the Mind, the product designed and created is part of the presentation that explains the solution to the problem instead of helping to solve the problem. This is where the conceptual framework of the PM relies heavily on students seeking to balance between project-based and problem-based learning. If they do

not find a balance, then the learning outcome tilts more towards either problem-based or project-based framework and the desired learning is not achieved.

Another instructional strategy that is similar to the PM (Shepherd, 1998) is Inquiry-based Learning (IBL), where learning begins by having the teacher pose a problem and then the students decide on their own question to answer. This is comparable to the PM, where the students are active learners in deciding the complex problem they want to solve. Bell, Smetana, and Binns (2005) explained that students who are learning through the inquiry learning process are actively engaged learners because they are gathering and analyzing information to answer the research questions. The difference between the PM and IBL is that IBL embraces a problem-based learning framework and relies strongly on data analysis to solve the problem instead of on project-based learning strategies. That is because there is no product to help solve the problem.

The opportunities students have to implement 21st century skills constitute the most critical aspect of the conceptual framework PM (Shepherd, 1998). Having a learning model that promotes 21st century skills is the catalyst to developing lifelong learners and productive citizens. The components of the framework for 21st century learning (Partnership for 21st Century Learning, 2014) that are included in the PM are: (a) learning and innovation skills (i.e., critical thinking and problem solving); (b) information, media, and technology skills (i.e., information literacy and media literacy); and (c) life and career skills (i.e., initiative and self-direction).

These 21st century skills propel the PM (Shepherd, 1998) as a learning model, which ensures that students are properly prepared to be competitive locally, nationally,

and globally. Having students who can think critically, solve complex problems, work creatively and collaboratively, know how to search for solutions to complex issues, and are highly engaged and motivated to learn will provide the necessary foundation for well-educated and productive citizenry.

This study eliminated the traditional lecture instructional model it focused on the PM (Shepherd, 1998), which engages students in an authentic constructivist learning environment. Students sought a solution to a problem by researching, working collaboratively, designing, and building a product that helped solve the problem. The PM allowed students to learn in a environment that replicates the skills necessary for success in the 21st century workforce.

Definitions of Terms

Terms essential to the literature review and used within this study are defined and elucidated as followed:

Constructivism: Constructivism encourages students to construct new knowledge and understanding through authentic real world experiences. This learning paradigm provides learning opportunities that allow students to think critically, problem solve, collaborate, and to become highly engaged within their learning process (Duffy & Jonassen, 1992).

Critical thinking: Critical thinking is a process of thinking that involves gaining knowledge by the execution of high order thinking and reasoning skills (i.e., Bloom's taxonomy). Thinking critically promotes metacognition (i.e., thinking about thinking) and

reflective thinking when solving complex problems/issues (Facione, 1990; Paul & Elder, 2010).

Probe Method: The PM is a learning model that merges problem-based and project-based learning while providing the opportunity for students to think critically, solve complex issues while stimulating students' motivation to learn (Shepherd, 1998).

Problem-based learning: Problem-based learning is a learning methodology that occurs when students are presented with a problem to solve and they must research solutions to the problem (Ribeiro, 2011).

Project-based learning: Project-based learning (PBL) ensures adequate amount of flexibility and multiple solutions to obtain the objective of the activity while at the same time challenging the learner. In a project-based learning environment, students participate in authentic projects which encourages multiple forms of problem-solving to occur within its instructional format while at the same time allowing students to reflect over stages, steps, and/or processes that occurred during the project (Buck Institute for Education, 2012).

Reflective thinking: Reflective thought is a process that encourages retention of information resulting in understanding of a concept. Experiences and knowledge are critical to reflective thinking; therefore, educational learning needs to include instructional designs that provide a wealth of authentic experiences that emulate real world situations that requires students to relate new knowledge with past understandings (Dewey, 1910; Collier, 1999).

Assumptions

This case study was founded on three assumptions: (a) that all participants would provide honest answers to the best of their ability; (b) that the students and the teacher who were selected to participate in the student/teacher interviews would recall to the best of their ability and provide detailed explanations about all events that took place during their PM project-based lesson; and (c) that positive social change would occur with the PM. Consequently, CTE teachers would have a researched learning model that motivates learning and activates critical thinking skills which could now be part of CTE teachers' repertoire.

Limitations

This single case study was limited in scope because it took place in one high school and only one classroom. Even though this study was narrow in scope, it was able to provide essential information about the PM (Shepherd, 1998) in a CTE program. As Merriam and Associates (2002) explained, qualitative case studies search for the significance and understanding within the complexity of a case. Therefore, this case study could be used for other CTE programs throughout the United States of America because it will supply the educational pipeline with knowledge and understanding of a researched learning model.

Another limitation of this case study was narrowed by time and location. Time prove to be a limiting factor because the end of the school year was approaching and moving of the students for EOCT testing took place sooner than the administration had previously announced. The high school in which this study took place used every

computer lab (i.e., classrooms with 28 or more computers and designated computer labs). Consequently, the engineering classroom had to move to another classroom during the EOCT testing period. This limited students to using their own devices (e.g., smart phones etc.) and two computers supplied in the other classroom. This affected some students who did not have their own digital devices because they had to wait for a computer to become available and gather their research.

Significance

The significant aspect of this case study was to provide a body of knowledge on the impact of the PM (Shepherd, 1998) on high school students' motivation to learn and their critical thinking skills when they participate in a CTE program.

In reviewing the current literature no case studies on the PM (Shepherd, 1998) were found pertaining to PM's impact on high school students' motivation to learn and critical thinking skills when implemented in a CTE program. The research literature did reveal that G. Shepherd, the designer and researcher of the PM, introduced the PM in his quasi-experimental dissertation (Shepherd, 1998). In his dissertation, Shepherd referred to the PM as a curriculum intervention that would provide teachers with researched instructional strategies that would encourage students to implement higher-order thinking and develop inquiry skills while activating self-motivation within their learning process (Shepherd, 1998). A recent mixed-method study by J. Vish (2013) was conducted on the PM; it examined how the PM affected motivation and the academic achievement of high school students in a social studies classroom.

According to Shepherd (1998), there is a need in education for instructional models that motivate students to learn and promote critical thinking skills. The PM is based on a constructivist learning theory that students should be active participants in their learning and are provided the opportunities to acquire that knowledge (Shepherd, 2012). The PM allows students to take responsibility for their learning in a learning environment that mirrors real-world working environments, environments that include technological integration, complex problems, collaboration, as well as self-directed learning.

Shepherd's (1998) purpose for conducting his study was to determine if the PM was an effective learning model for developing students critical thinking skills and motivating students to learn while they solved complex problems. His study concluded that the PM (Shepherd, 1998) is an effective curriculum invention in getting students to think critically, solve complex problems, while motivating students to learn. Shepherd's goal was to replicate required 21st century workforce skills within an educational learning environment (1998).

Summary

Chapter 1 in this study provided the background to the study that included an overview of the literature that focused on CTE programs and the need for learning models that promote motivation and critical thinking skills so that students are prepared for the rigor of the 21st century workforce Also, the Chapter 1 presented the purpose of the study, which was to explore the role and function of the PM has on high school students' motivation to learn and critical thinking skills as they are participating in a CTE

program, as well as, how this study will assist in promoting positive social change by providing high school CTE educators with a learning model that promotes motivation for learning and critical thinking.

Additionally, the purpose and nature of this study was to implement a qualitative case study to explore the role and function of the PM as an instructional model for addressing motivation to learn and critical thinking skills among high school students in a CTE program. Finally, the theoretical framework of constructivism, RQs, and definition of terms were provided for the foundation for this case study.

Chapter 2 provides the review of current literature on student motivation, critical thinking, project-based learning, problem-based learning, and technology. The review confirmed the gap in the literature with high school students not being prepared for the rigors of the workforce because there is a lack of learning models that activates students' motivation to learn, promotes critical thinking skills, and provides the opportunities to solve complex problems in a technological learning environment. The Chapter 3 presents the research design and rationale, the context of the study, the data sources, the procedures for data collection, and the data analysis plan for this case study. In Chapter 4, data analysis is performed on the findings and results gathered from the data collection. Finally, Chapter 5 describes the interpretation of the findings, limitations of the study, potential impact of social change, and recommendation for future research.

Chapter 2: Literature Review

Introduction

The purpose of this qualitative case study was to explore the role and function of the PM (Shepherd, 1998) as an instructional model for addressing both motivation to learn and critical thinking among high school students in a CTE program.

The purpose of this literature review was to highlight the key components of the PM learning model (Shepherd, 1998) and its conceptual frameworks of project-based and problem-based learning, the constructivist paradigm, and the framework for 21st century learning (Partnership for 21st Century Learning, 2014). In this literature review, there is an examination of the constructivist theory, as well as, past and current theorists who have been instrumental with establishing the theoretical foundation of constructivism. Since there were few literature reviews pertaining to the PM, it was critical to provide a historical foundation of key components of the PM, which include motivation to learn, critical thinking, problem solving, and technology integration. A summary of the constructivist theorists (i.e., John Dewey, Seymour Papert, Jean Piaget, and Lev Vygotsky) was a major section in this review. Current research findings on traditional learning, career technical education, and technology integration are presented to enhance understanding of past and current trends in education. Also examined in this literature review are two major initiatives in education: bring-your-own technology (BYOT) or bring-your-own devices (BYOD). These initiatives encompass research findings on technology integration into the learning process.

This review of the literature will provide in depth knowledge and understanding of the requirements needed for teaching students in the 21st century. The knowledge gained should help educators ensure that learning models can effectively and efficiently provide students with 21st century learning and skills, for example, motivation to learn, critical thinking, problem solving, and technological integration.

Literature Search Strategies

The following databases were used to search for relevant and current information for this qualitative case study and to help answer the RQs: EBSCOhost, Education Research Complete, Google Books, Google Scholar, and Sage Journals Online. The key search terms used to locate the information in the databases were as follows: *active learning, career and technical, career readiness education, critical thinking, collaborative learning, constructivism, CTE, educational reform, frameworks for 21st century learning, information literacy, inquiry-based learning, Jean Piaget, John Dewey, Lev Vygotsky, media literacy, motivation to learn, Odyssey of the Mind, probe method, problem-based learning, project-based learning, reflective thinking, Seymour Papert,* and *technology integration.*

Conceptual Framework

The conceptual framework for this study included the constructivist paradigm, the framework for 21st century learning (Partnership for 21st Century Learning, 2014), and project-based and problem-based learning strategies. In this study, these conceptual frameworks are structural components of the PM (Shepherd, 1998). The constructivist paradigm is explained to provide the overall theoretical foundation of the PM.

Constructivist theorist Dewey, Piaget, Papert, and Vygotsky are highlighted because of their support and contribution to constructivist paradigm which is the conceptual framework utilized by the PM. These theorists provided an in depth understanding and knowledge of constructivism and its learning strategies that have shaped education in the twentieth and 21st century.

Two instructional learning strategies (i.e., Project-based learning and Problem-based learning) are explored because they both have specific elements that are critical to the uniqueness of the PM (Shepherd, 1998). Since the PM embraces both project-based and problem-based learning, a balancing act occur between both instructional strategies. It is during this balancing act that equilibrium between both instructional strategies are sought to solve a complex problem.

21st century skills are the most critical aspect of the PM (Shepherd, 1998) because individuals need to be able to think critically, be highly motivated to learn, solve complex problems, and have the ability to research solutions to problems or issues, and work collaboratively so that they can survive in this dynamic global society. The framework for 21st century learning from Partnership for 21st Century Learning (2014) was used to feature the following skills: Motivation, critical thinking, and problem solving. Also, media and literacy skills were explored because of the need for students to be able to locate specific information within the enormous amount of information available digitally.

Conceptual frameworks pull key elements that being studied to find a common relationship among those key elements (Miles & Huberman, 1994). The conceptual

framework for this study relies on the constructivist paradigm, the framework for 21st century learning (Partnership for 21st Century Learning, 2014), and project-based and problem-based learning strategies to find the relationships among the main components that support the PM (Shepherd, 1998). Since there is limited information about the PM, these conceptual frameworks will help provide an explanation of the structural components of the PM.

The PM

The PM (Shepherd, 1998) is a constructivist learning model that embraced project-based and problem-based learning and has had success at the elementary school level that encouraged students to think critically, inquire and seek solutions to problems, work collaboratively with peers, and learn to be self-directed learners. The PM is a learning model that follows the learning processes that theorist Dewey, Papert, Vygotsky, and Piaget prescribed when students worked in an authentic constructivist learning environment. This learning model replaces the passive traditional learning method and infuses Dewey's (1920) "learning by doing" active learning method. The PM is designed to be used alongside technology integration. Many middle and high schools across America are incorporating bring your own technology/devices which has made implementing technology within the learning process much more efficient and effective. The PM is a learning model that uses technology as part of its structure and works more cohesively with the 21st century student.

Dr. Norman "Glenn" Shepherd created the PM in 1998. According to Shepherd (2010), the PM is an instructional learning method that implements 21st century skills and

can be used within any grade level. Shepherd (1998) investigated fourth and fifth students critical thinking skills when they used the PM within a social study assignment. The questions for his study are as followed:

- What affect will the implementation of the PM in a fourth and fifth grade classroom have upon students' critical thinking abilities?
- When students use the PM, will they have a positive attitude about learning and solving complex problems? (Shepherd, 1998, p. 15).

Shepherd (1998) concluded that when students are provided the correct framework to problem solve, think critically, collaborate, inquire, and reflect while seeking solutions to real-world problems/issues, students increase their motivation to learn, improves their critical thinking abilities, and they are able to solve complex problems.

Shepherd's (1998) study took place in a Midwestern private school with 35 fourth and fifth grade gifted students in a social studies program. Twenty students who participated in the PM experimental group was given an architecture social action project and had to solve the following question "How can we provide suitable housing for all the people in the world?" (Shepherd, 1998, p. 57). Fifteen students who did not participate in the PM and were part of the control group were provided a traditional classroom lesson on architecture (Shepherd, 1998).

Both quantitative and qualitative data was used to determine if the PM was an effective curriculum intervention in the areas of critical thinking, problem-solving, and self-motivation toward learning (Shepherd, 1998). Using the Cornell Critical Thinking Test (CCTT), Level X, Shepherd (1998) collected quantitative data from a pre-test and

post-test from an experimental group of 20 students who received instruction using the PM and from a control group of 15 students who did not receive instruction using the PM.

In addition, Shepherd (1998) collected qualitative data from 20 students in the experimental group by videotaping and observing classroom sessions during the implementation of the PM over a nine week period. Also, student surveys, interviews, and journals provided insight on students' perception of the PM (Shepherd, 1998). An interview from the teacher, who implemented the PM, was conducted to provide feedback on the role and function of the PM had on students' attitude toward learning, problem solving, and critical thinking (Shepherd, 1998). Ensuring that the control group students were receiving a different type of instruction, Dr. Shepherd conducted observations and an interview with the teacher of the control group (Shepherd, 1998). The conclusion from the quantitative research data collected from Shepherd's study revealed

> The mean scores of the difference between the pre-and post-test for the control group who did not use the PM was not significant ($p = 0.77$) . . . the experiment group who used the PM was significant ($p < 0.0001$). (Shepherd, 2010, p. 5)

The qualitative results from Shepherd's study concluded that the teacher as well as the students positively reported that the PM made learning interesting and encouraged students to learn (Shepherd, 2012).

The foundational structure of the PM is based on constructivist learning environment that blends both problem-based and project-based learning models

(Shepherd, 1998). Taking the basic elements of problem-based learning and merging it with a cooperative learning environment and technology allows students to "probe" for solutions that mirror a real-world working environment (Shepherd, 2012).

Technological integration is a key component of the PM because it allows students to go beyond their classroom and library. During Shepherd's (1998) study, students were given the opportunity to use the Internet to aid in their quest for a solution to their problem. At the time of his study, the Internet was just coming into classrooms across America. Many of the students had to learn how to maneuver the basic of surfing the Internet as well as learn how to distinguish between factual and nonfactual information (Shepherd, 1998). At times, students became frustrated, but as with all new technological advancements it takes practice and time to learn how to maneuver through technological programs and allowing students to work collaboratively aided in students confronting the challenges of the Internet (Shepherd, 1998).

Modifications were done to assist students on understanding the material they found on the Internet and students had to learn how to analyze and summarize the information they had collected (Shepherd, 1998). Overall, the learning experience received by using the PM was extremely positive and supportive for this new curriculum intervention (Shepherd, 1998). Furthermore, Shepherd (2012) explained that the PM allows for 21st technological innovation to be included within this learning model. Consequently, allowing students to reach beyond their own classroom and seek answers from the global community.

Shepherd (1998) discovered through students' journals and his observations of the experimental group that technology increased student attitude about doing a major project that required them to think critically and solve a complex problem. Once the modifications occurred and students' confidence with technology increased, so did their attitude toward learning. Implementation of problem-based learning with cooperative learning was enhanced with the aid of technology for this major project.

The success of the PM at the elementary grade level reinforces the importance of having researched learning models to use within the high school CTE programs. Getting students to think critically and problem solve are important issues facing high school teachers; however, motivating students to learn is the catalyst that ignites the desire to think critically and problem solve. Having a learning model that ignites positive attitude toward learning provides the opportunities to think critically, and encourages students to inquire and seek solutions to problems, is an essential component needed at the high school level in a CTE program.

Vish (2013) implemented a mixed-method research study of the PM at the ninth grade high school level from an inner city in the Midwest. Vish focused on how the PM when used in a social studies learning environment improves student motivation, academic achievement, as well as documented perceived strengths and weakness of this learning model. Vish discovered that students in the experimental group's motivation decreased after the implementation of the PM compared to the control group. The control group utilized a traditional lesson model and had a slight increase in motivation (Vish, 2013). The same results occurred for academic achievement and overall motivation levels

which decreased with the implementation of the PM in the experimental group whereas the control group's increased. Survey questions from the two instructors revealed that the experimental teacher felt students at this particular high school did not have a solid foundation in problem-solving skills and suggested that teachers should have more training before implementing the PM. In addition, the experimental teacher felt the PM would be better suited in elective classrooms which are known as CTE programs.

Even though Vish's (2013) results were not the same for high school as Shepherd's (1998) results were at the elementary level, both studies did find that students were motivated using the PM (Shepherd, 1998) because this learning model allowed students to have an alternative method to learning concepts which are often taught through the method of a didactic instruction. Students in both studies were provided opportunities to learn in a constructivist learning environments which parallels the format of real-world workforces found in the 21st century. While the results were not conducive to each other, students in both studies had an increase in their students motivation to learn (Shepherd, 1998; Vish, 2013) and they developed collaboration, communication, critical thinking which activated solving complex issues, information literacy, and media literacy skills which are 21st century skills needed to operate competitively in the 21st century global society.

Constructivism

Constructivism is a learning paradigm that engages students to be active in their learning process as they construct new knowledge and understanding. In this study, constructivism provided the framework to investigate if the PM actually engages students

in meaningful instruction by motivating them to learn and provides the rigor to promote critical thinking.

Hubbard (2012) concurred with Dewey and Papert that students should have the opportunity to construct their own knowledge and understanding by being active participants in the learning process. Instead of just receiving information, students need to be participating, reflecting, collaborating, researching, consulting, and problem solving as they progress through the learning process (Hubbard, 2012). In his case study, Hubbard experienced true constructivism in his video production class. Students became self-directed learners who used their prior experiences from previous video production classes and worked collaboratively by solving complex issues, editing the movie, and creating a finished product that met the requirements for the finished project. All of this happened in an active learning environment with guidance from the teacher. Hubbard noted that the students working on this project were highly motivated and engaged in the tasks that produced a professional video.

The passivity of students in the educational system limits real-world exposure and events which constricts the construction and development of new knowledge and understanding. This flaw in the American public school system prevents the utmost goal of learning, which is to produce highly skilled and educated productive citizens.

Branches of Constructivism

Since constructivism is a newer learning theory, it is still evolving with time. There are two branches of the constructivism theory in education. In this study, constructivism will embrace both cognitive and social constructivism because the PM

(Shepherd, 1998) is based on the cognitive and social constructivism theory. Some research studies will focus on either the cognitive or the social aspects of learning while other research studies focuses on both the cognitive and social aspects of the learning environment. Therefore, understanding the difference between cognitive and social constructivism can be of assistance when having to look at the different components of the constructivist learning environment.

In a constructivist learning environment, students are actively engaged in their learning process compared to students who sit passively receiving instruction in a behaviorist learning environment. Education in the United States of America has slowly shifted toward constructivist learning over the last century. However, this shift has sped up because of the technological revolution and the rapid expansion of technology throughout the world. Technology has become the landscape of education and is a tool that assists and enhances the learning process and has rapidly expanded globally—in all sectors of society (Gikas & Grant, 2013). This new age of technology requires education to meet the demands of the world which is to provide authentic learning that motivates students and promotes critical thinking which leads students to be innovators and problem solvers of complex issues or problems.

Constructivist Theorist

Dewey, Piaget, Papert, and Vygotsky are constructivist theorists who agree that learning should be an active process that reflects the real world. These four theorists are important in education because of their contribution to the understanding of cognitive development in a constructivist learning environment. Dewey (1920) and Papert (1980)

stressed that learning for students need to be an active process. This is evident in Dewey's theory of learning by doing and Papert's experiences with technology integration into the learning process. Even though Dewey and Papert were separated by a half a century, they both concluded that students who are active participants in their learning become motivated and engaged which leads to a higher levels of learning. Papert (1980) and Piaget (1969) whom had the opportunity to work with each other were able to experience true constructivism in the learning environment and concluded that cognitive development is enhanced by incorporating constructivism into the learning process.

Dewey, Piaget, Papert, and Vygotsky highlighted the importance that students must be actively engaged and interacting within their learning environment to construct new knowledge and understanding. These four constructivist theorists' contribution to education was the establishment of a solid theoretical foundation known as constructivism which provides an active learning environment that motivates and challenges students. Consequently, constructivism is critical to education because students who are engaged with their learning are less likely to drop out of school (Aud et al., 2012). For this reason, constructivist learning models are needed that stimulate motivation for learning and provide students opportunity to experience learning that replicate the real world.

John Dewey

John Dewey (1920), a constructivist theorist envisioned school to be a place that allowed students to move freely within a classroom during lessons. Dewey wanted schools to resemble small workshops where students could explore and create products.

Since Dewey lived during the early part of the twentieth century, schools were focused on educating the masses because of the industrial revolution in the United States of America. Consequently, Dewey wanted to reform school because he believed students' cognitive development was being stifled by the behaviorist learning environment in which the students of the early twentieth century where being taught. In this learning environment, students sat in rows with the teacher supplying the information and the students memorizing the information. There was limited, if any, active participation on the students part and critical thinking was limited (Dewey, 1920).

Prior to the industrial revolution, many people lived on farms or in small towns where the children worked on these farms or performed the trade of the family. A few attended one room school houses, but many were educated at home. Students learned by doing and this was the learning framework that Dewey wanted to imitate in the educational system of the twentieth century (Dewey, 1920). Dewey (1920) noted that he wanted students to learn by exploring their environment which included the outdoors. Students would be able to gain familiarity with real world experiences by venturing beyond the four walls of the classroom. This type of learning environment would encourage students to explore, inquiry, and discover new knowledge and understanding of the world in which the student lived.

Also, Dewey (1920) did not like how the educational system in the United States of America was separating subjects and teaching concepts in isolation of each other. Dewey's constructivist learning environment embraced a multiple discipline concept where multiple subjects are taught and interwoven into the lesson. Dewey concluded that

this method of teaching resembled a patchwork of learning. Students have to take the learning from each subject and patch the concepts together to understand the concept. Unfortunately, this type of learning is still the overall structure of the educational system in the United States of America in the 21st century. Dewey wanted a major educational movement that would create a total reform of the educational system that would steer education toward the constructivist learning environment. Dewey (1920) sought for school reform because he stated,

> Now the change which is coming into our education is the shifting of the center of gravity. It is a change, a revolution, not unlike that introduced by Copernicus when the astronomical center shifted from the earth to the sun. (p. 35)

Dewey desperately wanted educational reform because he wanted education to focus on the child instead of the masses and mirror the real-world in which a child lived instead of four walls where students regurgitated information provided by the teacher. This learning environment would allow the child to reflect upon its newly constructed knowledge and develop a foundation of deep understanding.

Dewey's theory of active learning is a key element that has been missing in education because students have been sitting passively in their rows of desks waiting for the teacher to supply the information. But with the emergence of the technological revolution in education, Dewey's vision of a constructivist learning environment is in many classrooms across the United States (Duffy & Jonassen, 1992). Getting students to be active participants in their learning can be a difficult task for teachers. Therefore, teachers need to use the correct methodologies and learning strategies that will provide

students with the skills to be active participants in their learning. The PM (Shepherd, 1998) is an instructional strategy that builds upon Dewey's theory of learning by doing.

Seymour Papert

Seymour Papert, a constructivist and constructionist theorist, worked alongside Piaget and learned how students learn in a constructivist learning environment. Papert (1993) was a mathematician from Massachusetts Institute of Technology (MIT) in Cambridge, Massachusetts. At MIT, Papert began working with computers and realized computers could be a valuable tool to assist student with their learning (Papert, 1993). Papert also worked with Jean Piaget, who is known as the father of cognitive development theory and learned about the various cognitive developmental stages for learning (Papert, 1993).

Piaget and Cook's (1952) cognitive developmental stages are sensorimotor period (years 0–2), preoperational period (years 2–7), concrete operational period (years 7–11), and formal operational period (years 12 and up). As Papert began working with students, he noticed that students were having a difficult time with mathematics because many of the students were not able to move from the concrete stage to the formal stage. So, merging his philosophical knowledge of cognitive development stages and his knowledge of computer programming, Papert reformed education by integrating technology into the learning process.

Papert (1993) built upon his constructivist knowledge and infused it with a project-based learning environment. By bringing the theory of constructivism and project-based learning together, Papert was able to see students moving from the concrete

stage to the formal stage of cognitive development. Papert was able to successfully integrate technology by differentiating the lesson to meet the needs of his students while at the same time allowing students to work collaboratively with each other to solve complex problems and design and build a project. Also, Papert noticed that students motivation to learn increased and they were implementing higher levels of thinking skills.

Papert (1993) had been instrumental in bringing technology into education and providing evidence that constructivism worked cohesively with technology and project-based learning. Papert was an advocate for project-based learning starting in the early 1970's until his devastating accident in 2006 which has removed him from the world of academia. Papert's ultimate goal was to keep students in school by making learning challenging and exciting. When students are not able to go from the concrete stage to the formal stage of learning, students become frustrated which leads to them being unmotivated to learn. When this occurs, students are more inclined to drop out of school. Aud et al. (2012) stated

> The *status dropout rate* represents the percentage of 16- through 24-year-olds who are not enrolled in school and have not earned a high school credential (either a diploma or an equivalency credential such as a General Educational Development [GED] certificate)….declined from 12 percent in 1990 to 7 percent in 2010. (p. 82)

The goal in education is to provide a learning environment that motivates and challenges students. Aud et al. (2012) concurred with Papert that when students are engaged with their learning they are less likely to drop out of school. For this reason,

learning models are needed that stimulates motivation for learning and provides students opportunity to experience learning that allows for creativity and excitement.

Jean Piaget

As a psychologist and philosopher, Jean Piaget is best known in education as the father of cognitive development. He studied his three children extensively and documented how his children acquired and processed new knowledge. Piaget discovered that children process through stages as they grow. According to Piaget and Cook (1952), theses stages include sensorimotor (0-2 years), preoperational (2-7 years), concrete operations (7-11 years), and formal operations (from 12 years and up). Children proceed through each stage in sequential order. Some children will move faster through one stage to the next, but they cannot skip a stage (Piaget & Cook, 1952). During each stage of development children interact within their environment, therefore, developing cognitive structures or schemes. According to Piaget (1969), "A scheme is the structure or organization of actions as they are transferred or generalized by repetition in similar or analogous circumstances" (p. 4). Additionally, intellectual growth occurs within each developmental stage by the implementation of various fundamental processes to the scheme. These intellectual fundamental processes are assimilation, accommodation, and equilibrium. Gauvain (2001) explained, "Piaget proposed the twin mechanisms of assimilation and accommodation. These two processes help the organism to achieve equilibrium between what is known and what exists in the world" (p. 25). To further explain, Läge, Oberholzer, Egli, and Streule (2008) stated,

> When it comes to learning, people try (as a default) to integrate new experiences into the existing knowledge without restructuring the current schema. Our mind looks (automatically) for similar situations or perceptions in the past and tries to interpret new information from this perspective. (p. 29)

In education, this process occurs when students are provided new information by the process of scaffolding or building upon current or past knowledge (Läge et al., 2008). Educators need to ensure that students have been given time to absorb the information which allows for new knowledge and understanding to transpire. But, there will be occurrences that cannot be assimilated leading to disequilibrium. When disequilibrium strikes, confusion occurs (Läge et al., 2008). When confusion appears, educators must be able to effectively and efficiently make adjustments in the learning process so that a student can take prior knowledge as well as understanding and adapt that knowledge to the newfangled situation. This process is known as accommodation (Läge et al., 2008).

Since equilibrium is a state in which a person has balance between assimilation and accommodation which means that they have an understanding of their environment, it is uncomfortable for a person to be in a state of disequilibrium or not knowing (Berger, 2008). When a person is in the state of disequilibrium, they are more likely to be motivated to learn so that they can obtain a state of understanding (Berger, 2008). Thus, equilibration is the process that brings about equilibrium by moving a person from not understanding to understanding. One interesting point that Läge et al. (2008) highlighted was that assimilation will appear first because new information is merged with existing

information and accommodation will then take place as the new and existing information blend together.

There are two learning strategies that allow students the opportunities to experience disequilibrium and these learning strategies are project-based learning and problem-based learning. These two learning strategies provide the learning environment necessary for students to assimilate, accommodate, and reach equilibrium with their new knowledge and understanding of a concept. Project-based and problem-based learning allows students to construct their knowledge as they proceed through the intellectual fundamental processes. The PM (Shepherd, 1998) pulls strongly on the students' disequilibrium as a major component of its structural framework. Since the PM integrates both project-based and problem-based which both reinforce the disequilibrium stage in learning, the PM moves the students toward a state of equilibrium to achieve maximized learning potential of each student.

Lev Vygotsky

Lev Vygotsky, a theorist, believed social interactions is essential to increase learning. He believed that social interactions enhance knowledge which results in cognitive development. Vygotsky (1978) stated, "Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological)" (p. 57). Vygotsky truly believed that a person needs to have social interaction to reach his/her full cognitive development and social interaction can result from peer

collaboration or an adult guidance while the student is going through his/her learning process. This social collaboration is known as zone of proximal development, or ZPD.

When the social interaction and guidance is provided, the educator is able to see how the student solves problems which provides a foundation for the educator to determine the potential learning of that particular student. The shift in focus from what the student already knows which is often the measurement of Intelligence Quotient or I.Q. testing to the potential learning of a student is the basic foundation of ZPD. Vygotsky (1978) explained that cognitive development occurs only when students are actively engaged with people in the environment in which they are learning. He further explained that traditional teaching of regurgitation of facts is pointless and limits cognitive development (Vygotsky, 2012). If students required to repeat concepts without the opportunity to interact then in depth thinking does not take place. Even though Vygotsky's ZPD leans toward cognitivism, Vygotsky believed learning was a social interaction which is clearly in aligned with the constructivist learning theory.

Vygotsky's belief that learning is a social interaction confirms what business leaders are requesting from the academia world which is that students need to have the ability to work collaboratively with their peers or co-workers to ensure that a cohesive working environment can exist. This means that students need to have opportunities to learn how-to work collaboratively in a working and learning environment. The PM (1998) provides the opportunities for students to experience Vygotsky's ZPD because the structural foundation of this learning model mirrors the Vygotsky's ZPD stages where the students interact with both peers and the teacher.

Project-Based Learning

When an educational institution shifts theories, they usually change instructional strategies or methodologies. One particular methodology that works well with constructivism is project-based learning. Project-based learning environments allow students to participate in authentic projects that focus on complex problem solving. Grant (2011) noted that project-based learning is truly authentic learning because the learner is the active participant who is solely responsible for their own learning. In a constructivist project-based learning classroom, students are able to collaborate, think critically, reflect, and make mistakes. These key elements of a project-based learning method allow students to enhance their learning which ultimately increases their cognitive development.

Boondee, Kidrakarn, and Sa-Ngiamvibool (2011) explained that project-based learning focuses on the students as the center of the learning diagram instead of the teacher at the center. This shift in the learning process design encourages students to be active participants of their learning. Boondee et al. (2011) studied 32 industrial mechanic students from a technical college in Thailand whom had increased their academic achievement because they completed a major research and experiment project by using project-based learning. These students worked collaboratively via the Internet as well as in a laboratory to complete their assignment (Boondee et al., 2011).

As students completed an experiment in the laboratory they enacted cooperative learning for problem solving complex issues. These same students used the class web site to correspond with each other, share ideas and research, and present their final report in a

real-world working environment. Boondee et al. (2011) concluded that not only did student academic achievement increase by using project-based learning, but students also developed responsibility, collaboration, and work ethic skills.

Project-based learning ensures adequate amount of flexibility and multiple solutions to obtain the objective of the activity while at the same time challenging the learner. According to the Buck Institute for Education (2012), project-based learning occurs when students go through an extended process of inquiry in response to a complex question, problem, or challenge. It is through project-based learning environments that students have the opportunity to be active participants in their learning by allowing students to explore and make their own decisions within their learning process. Additionally, the Buck Institute for Education (2012) noted that teachers who implement a project-based learning environment will incorporate lessons that are academically challenging and will include 21st century skills (i.e., communication, collaboration, critical thinking, problem-solving, etc.). In these project-based lessons, students design, create, and build products that seek solutions to a problem. Nie and Lau (2010) conducted a research study that focused on two methods of learning, a didactic instruction, and a constructivist project-based learning instruction. In their study, they wanted to determine which instructional learning method yielded a better return on academic achievement. Nie and Lau revealed that constructivist project-based instruction has a significant advantage over didactic instruction in cognitive, motivational, and achievement outcomes. Based on their study, authentic learning resulting from a constructivist learning environment encourages motivation. This motivation increases students'

participation in their learning process hence supporting the Buck Institute for Education's (2012) belief that project-based learning stimulates learning by increasing student collaboration and excitement for learning.

Whereas Grant's (2011) study of five eight grade students in a private school who were not accustomed to learning in a project-based learning environment concluded that limited experience in a this type of learning environment placed more responsibility for learning the content back on the teacher instead of placing more of the responsibility on the student. Consequently, students were not completely maximizing the benefits of a constructivist project-based learning environment. Grant's study highlighted five particular themes that influenced students' decisions and actions for creating and completing their final tangible project. These five themes were internal influences, external influences, beliefs about projects, tools for technology-rich environments, and learning outcomes and products (Grant, 2011). These five themes are elements that occur in a project-based learning environment; however, students did not have in depth learning experience with these five themes. Students' lack of experience with project-based learning could be the culprit for students not being fully engaged with their learning and their responsibilities to gain in depth understanding and knowledge of the concepts being taught.

Additionally, in semi-structure interviews and observations with the five eighth grade participants, Grant (2011) affirmed that students' projects did not reflect all the learning students were gaining from the project. Therefore, using reflective journals and having discussions with individual students allows for the teacher to gain insight into

students' decisions on the material and why students chose one option over another (Grant, 2011). A project-based learning environment is designed to let the student inquire, discover, and design; and sometimes these essential learning skills are not noticeable to the teacher, therefore, the teacher needs to engage with the students to determine if in depth learning and understanding is occurring (Grant, 2011).

Grant (2011) discussed the importance of making sure that teachers design the project to meet the needs of each student which requires having material available for just-in-case the students' require additional guidance and scaffolding for understanding. Many educators view this type of advance planning as a burden and waste of time if students do not use the additional resources (Grant, 2011). There is much resistance to using a constructivist project-based learning method within the classroom, and proper educational training for teacher is critical to the success of project-based learning.

Seo, Templeton, and Pellegrino (2008) have determined that bringing PBL to educators at the beginning of their preservice training is essential for changing to constructivism across the educational arena because teachers learn how to effectively and efficiently implement PBL. Whereas, teachers who have not been correctly or have not received training tend to waver from implementing PBL within the classroom (Seo et al., 2008). In their research, a pre-test was given to the preservice teachers before the multimedia projects were assigned which revealed less than 50% were comfortable integrating technology. Interestingly, after the preservice teachers completed the multimedia projects which incorporated PBL, only 6% of the teachers were not comfortable with using technology within their classroom, compared to 94%. (Seo et al.,

2008). The confidence and knowledge gained by the teachers in their study demonstrated that training is essential for educators to effectively integrate PBL within the instructional design. Engaging and motivating students of the 21st century are two key components that retain the attention of students. As found in Grant's (2011) study, Seo et al. (2008) study pinpointed another key component about project-based learning which is—teachers are the key to ensuring students are engaged and motivated throughout their learning process and having the proper training for both teachers and students is important to ensuring maximized learning is occurring in a project-based learning environment.

Lam, Cheng, and Choy (2009) further confirmed that getting administrators and faculty to support a different methodology can be a challenge. In their study, Lam et al. (2009) highlighted factors that motivate teachers to embrace a new instructional methodology (i.e., project-based learning). Lam et al. (2009) study was conducted in Hong Kong with 180 teachers and the results concluded that teachers need to have the support of their school in collegiality, competence, and autonomy which results in these teachers having more confidence with using technology while using project-based learning. Teachers' motivation increases when they obtain support and they are more likely to implement the new instructional methodology.

Teacher training is a critical component of PBL. Proper training in PBL is essential to the successful implementation of this rising methodology that has proven to enhance the learning process (Nie & Lau, 2010). Tamin and Grant (2013) highlighted that educators learning to implement project-based learning must learn to be flexible and

allow the student to experience active learning. This method of teaching is different from the traditional based teaching and it is the educators' motivation for this learning method that influences the success of project-based learning. Tamin and Grant's (2013) case study highlighted how a teacher belief of a methodology affects how a teacher implements that particular instructional methodology. Tamin and Grant evaluated a teacher, but activated a multiple case approach and used several different teachers to assist in their case study of how a particular teacher implements project-based learning. In their study, the researchers concluded that a teacher's belief system of how a person learns overrides their decisions on how to implement project-based learning.

Rogers, Cross, Gresalfi, Trauth-Nare, and Buck (2011) investigated three ninth grade teachers who were implementing project-based learning for the first time and found that teachers belief of teaching (i.e., orientation) influenced how these three teachers implemented project-based learning. Two teachers taught ninth grade Biology and the other taught ninth grade Algebra. Two of the teachers received some professional development in project-based learning, and the other teacher did not receive any type of training because this was his first year of teaching (Rogers et al., 2011). Rogers et al. (2011) study contended that even though the two teachers who had some training in project-based learning and teaching experience, their teaching orientation influenced their overall method of teaching. The teacher with no professional development training in project-based learning pulled from past experiences of his recent student teaching experiences. Similar to Tamin and Grant (2013), Rogers et al. collective case study concluded that when educators switch to a different teaching method, they need to have

in depth professional development of the instructional design so that the influences of past teaching methodology and beliefs do not dilute the new instructional design. Rogers et al. explained that teachers' lack of understanding and knowledge of project-based learning strategies could complicate how to effectively and efficiently implement project-based learning to it fullest potential.

In both studies, Rogers et al. (2011) and Tamin and Grant (2013), the teachers found that project-based learning encouraged students to develop or improve 21st century workforce skills (i.e., collaboration, research skills, reasoning, motivation, and communication skills). Project-based learning is a catalyst for bridging traditional learning with active learning. But, educators around the world need be properly train on how to implement project-based learning in all disciplines of the educational system (Nie & Lau, 2010; Rogers et al., 2011, Grant, 2012; Tamin & Grant, 2013).

Knowing and understanding the historical background of constructivist project-based learning that is used in conjunction with technological innovations provides the foundation of how this learning methodology is gaining support as a lead contender as a method of instruction for academia of the 21st century.

Problem-Based Learning

Problem-based learning has a similar component to project-based learning which is that problem-based learning "is based on the assumption that learning is not a process of reception, but of construction of new knowledge" (Ribeiro, 2011, p. 2). Savery (2006) added that problem-based learning "is an instructional (and curricular) learner-centered approach that empowers learners to conduct research, integrate theory and practice, and

apply knowledge and skills to develop a viable solution to a defined problem" (p. 12). Ribeiro (2011) stated that problem-based learning "is essentially a collaborative, constructivist, and contextualized learning and teaching approach that uses real-life problems to initiate, motivate, and focus knowledge construction" (p. 2). In his study, Ribeiro found that the integration of a problem-based learning curriculum was difficult at first to implement for a secondary education engineering professor, but as time passed, the professor made adjustments and noticed that students were more motivated to learn using problem-based learning. Also, problem-based learning provided the teacher the opportunity to provide individual attention to each student. Ribeiro concluded that by using problem-based learning, the professor was able to learn more about how students put into practice their reasoning skills while solving complex problems. Even though the professor did not like some aspects of the problem-based learning (i.e., increased planning time, could not keep to a scripted lesson, and limited participation in other scholarly duties required of higher educators), the professor was impressed with how the students worked collaboratively and how his own teaching practices were improved (Ribeiro, 2011). Problem-based learning allowed the professor the opportunity to reflect over his teaching practices and he was able to make adjustments throughout the course (Ribeiro, 2011).

Celk, Onder, and Silay (2011) investigated 44 physics teacher candidates from Dokuz Eylül University, Turkey and the researchers concluded that the 20 experimental group members who were taught using problem-based learning scored higher on the posttest compared to the 24 control group members who were taught by using traditional

lectured-based learning. Since problem-based learning is student-centered, students are more likely to stay motivated to learn because they can work collaboratively to solve complex real-world problems (Celk et al., 2011).

Both Riberio (2011) and Celk et al. (2011) studies described the positive benefits of problem-based learning has on the learning process. Students are provided a real-world problem and they must solve the problem by pulling from prior knowledge, collaborating with team members, researching the problem, and communicating possible solutions (Riberio, 2011; Celk et al., 2011). Through problem-based learning, students gain exposure to real-world problems allowing students to experience and explore complex problem that are not available in a traditional learning setting.

21st Century Learners

Educators are seeking learning models to enhance cognitive development for students of the 21st century; therefore, educators need to have a repertoire of researched learning models that promote motivation, cultivate active engagement, improve cognition, infuse critical thinking, as well as encourage complex problem solving. Since students of the 21st century are technologically astute, integrating technology into the instructional design is essential for students to be competitive in the global society. In the age of technological advancements, technology allows students sometimes to take an active role in their learning when technology is integrated into students learning.

Hung, Hwang, and Huang's (2012) study of 117 fifth grade students in southern Taiwan found that when students integrated digital storytelling technology into their project-based learning environment throughout the entire lesson, students' became highly

motivated which improved their problem solving skills while increasing their academic understanding of the concepts being taught. Similar findings were found in two studies conducted by Halpern, Millis, Graesser, Butler, Forsyth, and Cai (2012) which implemented a computerized learning software to help teaching college students to think critically and develop scientific reasoning. The results of Halpern et al. (2012) studies concluded that adaptive learning technology improves learning for a variety of diverse learners.

Technology allows the four walls of the classroom to disappear and a different type of learning appears. Technology integration is able to provide the environment that allows students to work independently with teacher guidance or collaboratively with peers when learning a new concept, learning becomes the responsibility of the learner, not the educator. Having learning models that integrate technology into the learning process provides students the opportunity to take responsibility for their learning and develop skills to be self-directed learners which are critical skills required of the 21st century workforce.

Keeping students engaged, motivated, while at the same time improving their cognitive development can be achieved by changing from a passive traditional or didactic instruction to an active learning environment. An active learning environment allows educators to bring excitement and motivation back into realm of learning. It is the responsibility of the teacher to ensure students have appropriate learning models available to them and a learning methodology that works cohesively with that learning model to achieve the require skills and learning strategies the society is requiring from its

students. Halpern et al. (2012) noted that school curriculums and materials need to match the 21st century skills of their students so that learning environments appeal to the 21st century students.

Education needs to remove the structure of fact giving, allow students to inquire, think critically, and reflect on a majority of their learning (Scott, 2010; Lim, 2011; and Liang, 2012). Liang (2012) indicated that secondary education institutions are looking for new learning models that incorporate real-world experiences into the learning process. Reducing the teacher lectured lessons while increasing lessons that are highly organized that integrate technology, embrace critical thinking activities, allows for reflective thought, and solve real-world problems is what constructivist necessitates for maximized learning. Lim (2011) highlighted that information from the Internet is instantaneous and abundant. Keeping students engaged in the learning process while allowing them to experience real-world issues through technological devices is a challenge many educators face on a daily basis because the access to information is unlimited. Wang, Woo, Zhao (2009) affirmed that there is a vast amount of information resulting from the rapid technological advancement of technology. As a result, technology requires people to have critical thinking skills to decipher the numerous amount of information by being able to analyze, synthesize, and understand a variety of viewpoints (Wang et al., 2009).

This unlimited access to information from technological devices creates another dilemma for educators which require students to have information and media literacy skills. Getting students to develop information literacy and media skills is a daunting task because according to Van de Vord (2010) students of the 21st century are deficient in the

skills needed to be information and media literate. According to American Library Association (2014), an information literate person is able to locate, sort through the vast amount of information, and determine what is relevant and what is not. The National Association for Media Literacy Education (2014) stated that to be media literate is to have "the ability to access, analyze, evaluate, and communicate information in a variety of forms" (para. 3). Young (2012) stressed that information and media literacy skills are essential for society so that people can retrieve and understand the information they have gathered so they can use that information correctly.

In a study of online students' research skills and the measure of their information literacy and media literacy, Van de Vord (2010) found that information and media literacy programs blend cohesively with each other. Therefore, ensuring students are taught media literacy skills enhance students' information literacy skills. Ashley, Lyden, and Fasbinder (2012) investigated 99 college freshmen from a Midwestern university who were not participating in a course that taught media literacy. The purpose of Ashley's et al. (2012) study was to find out the "baseline knowledge and understanding" (p. 231) of media literacy and the level of critical literacy. Ashley et al. (2012) concluded that students were could not decipher multiple amount of media information. There are similarities between Ashley's et al. and Van de Vord's studies in that media literacy evokes critical thinking skills when students have a solid foundation of knowledge and understanding of the components of media literacy; however, most of the students who participated in both studies lacked the ability to think critically and determine the message of the media presented. It is imperative that high schools, colleges, and

universities incorporate information and media literacy skills within their students learning process. Vijayaratnam (2012) argued that classrooms today do not mirror the real-world. The success of the work place depends on how effective and efficient a person can retrieve accurate and relevant information by having the ability to decipher the message of a variety of media sources and information.

Neo and Neo's (2009) study found that 53 second year college students in Malaysia had a favorable experience and attitude toward a constructivist multimedia technology learning environment. In their study, Neo and Neo concluded that students' motivation, problem solving skills, critical thinking skills, team work, and creativity were enhanced because of the constructivist multimedia learning environment. Students had to work collaboratively to design a multimedia project which replicated real-world experiences found in the workforce. Neo and Neo's (2009) study implemented a 30-item, 5-point Likert scale survey at the end of the course and found that "94.3%" (p. 260) of the students reported they were highly motivated to learn using a technology integrated constructivist multimedia project.

Similar to Neo and Neo's (2009) study, Vijayaratnam's (2012) study found that students who were provided the opportunity to work on real-world tasks in a problem solving learning environment improved their communication, critical thinking, and problem solving skills. Both Neo and Neo and Vijayaratnam studies described how students had difficulty working with other team members in their group. This is an area that both studies highlighted as needing more development and practice. Having students

practice and develop team skills is a soft skill that is essential in the highly dynamic workforce of the 21st century (Vijayaratnam, 2012).

Teaching students in the 21st century is quite challenging because every student has grown-up with having the Internet and/or numerous technological mobile devices. Martin and Ertzberger (2013) quasi-experimental study of undergraduate instructional design and technology students learning about particular paintings for an art lesson found that mobile technology increased motivation to learn in groups that used iPods and iPads in their learning compared to students who used only non-mobile computer based instruction. However, Martin and Ertzberger discovered that students who used only non-mobile computer based instruction scored higher academically on the posttest compared to the groups that learned using mobile devices of iPods and iPads.

While the technology is readily available to most students today, educators need to be cognizant of type of technology that best fits the learning instruction and desired academic outcome. As observed in Martin and Ertzberger's (2013) study, students using the mobile devices were more distracted in their learning while using their mobile devices compared to students learning with computer based instruction. Similarly, Wood, Zivcakova, Gentile, Archer, De Pasquale, and Nosko's (2011) study concluded that university students who were provided the opportunity to have technological devices in their learning environment were more distracted compared to students who did not used technology. Wood et al. (2011) determined that students with mobile devices and engaged with social media computer mediated tools were more distracted in their learning and scored lower academically compared to students who took paper and pencil

notes or used word processing note taking. Martin and Ertzberger's study, as well as, Wood's et al. study highlighted the need for educators to choose the correct learning model that integrates the correct type of technology that will produce the highest quality of learning for their students.

Even though current students (i.e., tech savvy students or digital natives) do not want to waste time on insignificant activities especially when they cannot see the connection to real-world application, it is imperative that educators implement the correct learning model with the correct technological devices for maximized learning. Consequently, educators need to develop lessons that replicate real-world situations that motivate students to learn and provide opportunities for students to think critically, while at the same time teaching the required standard-based curriculum required by the local, state, and federal government.

The PM (Shepherd, 1998) is a learning model that provides the teacher the opportunity to engage students while motivating them to learn. If the students are motivated with their learning, then they are more likely to activate critical thinking skills which gives them the confidence to solve complex problems (Martin & Ertzberger, 2013; and Wood et al., 2011).

Motivation

Getting 21st century students excited about learning is not an easy task for teachers in the classroom. Finding learning methodologies and learning models that promote motivation is important to keeping students engaged in their learning process. Motivation is an essential component that occurs within project-based and problem-based

learning. Lam, Cheng, Ma's study (2009) highlighted that there is an increase in both teacher and student intrinsic motivation for learning when learning occurs in a project-based learning environment. Their hierarchical linear modeling analyses of 636 students and 126 teachers at the secondary school level in Hong Kong revealed teachers who demonstrate intrinsic motivation will in fact influence their students' intrinsic motivation. Intrinsic motivation occurs when there is no reward involved and the person does the activity just because of the internal feeling they achieve from doing that activity compared to extrinsic motivation where the motivation occurs because of some type of external reward (Deci, 1972). Lam et al. (2009) noted that soft skills (i.e., collaboration communication, professionalism, etc.) are just as important to be taught to students of the 21st century because these soft skills are the same skills employers are seeking from their employees in the 21st century workforce.

Consequently, the educational system needs learning models that allow students to develop their soft skills in conjunction along with developing intrinsic motivation for their learning. Getting students intrinsically motivated can occur by having teachers prepare high quality project-based lessons that incorporate generic skills of collaboration, problem solving, and communication (Lam et al., 2009; Ocak & Uluyol, 2010). Lam et al. (2009) explained that the responsibility of learning is placed on the student instead of the teacher. The student is to take charge of their learning where they ask questions, research answers, think critically, and seek solutions to problems and issues all the while working collaboratively through all realms of the learning process. According to Lam's et al. study, the more a teacher was intrinsically motivated in the project-based lesson, the

student's intrinsic motivation increased because students' received greater instructional support from the teacher while learning in a project-based learning environment.

Ocak and Uluyol's (2010) study concurred with Lam's et al. (2009) study in that project-based learning encouraged students' interest in learning. Both studies sought to make the connection between students' intrinsic motivation while in a project-based learning environment. The results from these two studies concluded that students who are actively participating in their learning process reported they have an increase interest in the required tasks and activities. Ocak and Uluyol's study reiterates the importance of social collaboration among students and project based learning encouraged this social learning environment.

Intrinsic motivation is a sub-part of the education system that many learning environments want to incorporate, but do not emphasis or foster within the learning process (Lam et al., 2009; Ocak & Uluyol, 2010; Spinath & Steinmayr, 2012). Intrinsic motivation is an essential component of the learning process (Spinath & Steinmayr, 2012). Spinath and Steinmayr's (2012) study focused on competence beliefs and goal orientation which are factors that could influence intrinsic motivation at the high school level. Also, their study wanted to focus on high school students older than 16 years of age because previous studies on intrinsic motivation were conducted on elementary or middle school aged students where intrinsic motivation is still at a higher level compared to high school students.

The results from Spinath and Steinmayr's (2012) study highlighted that educators need to implement active learning environments so students have the opportunity to

experience intrinsic motivation to achieve their learning goals. Also, Spinath and Steinmayr (2010) discussed the value of having students reflect on their learning process by allowing students the time for reflective thoughts about what intrinsic motivates them to achieve their desired learning goals. Therefore, as long as students have learning-goals in place, then the fear of losing intrinsic motivation is lowered because students appear to maintain intrinsic motivation even if they do not meet their learning goals. In a project-based learning environment, students are able to experience their learning because the design of the learning environment encourages a completion of a product by working collaboratively with peers. Additionally, learning goals are established at the forefront and reflection of learning goals occurs throughout as the product is being designed and created.

Chang and Lee's (2010) two year study of high school students in Taiwan revealed that students and teachers embraced project-based learning. The first phase of Chang and Lee's study was conducted in a computer classroom with 10th grade students. The following year, the second phase, was conducted in 11th grade with the same students in their geography and English classroom. Having students trained the year previously by an experienced computer teacher of project-based learning, assisted the 11th grade geography and English teachers with implementation the second year (Chang & Lee, 2010). Both 11th grade teachers were novices to project-based learning and feared that class time would be wasted and students' academic achievement would decrease (Chang & Lee, 2010). Using the team-teaching approach was successful because it prepared students in the methods and processed of project-based learning before being

incorporated in core subject areas (Chang & Lee, 2010). Chang and Lee's study concluded students' motivation toward learning increased as well as their academic achievement in both subjects increased.

Critical Thinking

Providing students with a variety of learning opportunities are so important to the development of critical thinking, therefore, educators need to implement lessons that teach how to think critically. Paul and Elder (2008b) developed the Paul-Elder model of critical thinking which consists of

> 10 universal intellectual standards (i.e., clarity, accuracy, relevance, logicalness, breadth, precision, significance, completeness, fairness, and depth) that are used with eight elements (i.e., purposes, questions, points of view, information, inferences, concepts, implications, and assumptions) of thought which leads to the development of intellectual traits of virtues (i.e., humility, autonomy, integrity, courage, perseverance, empathy, confidence in reason, and fair-mindedness). (p. 19)

According to Paul and Elder (2010), "Universal intellectual standards are standards which must be applied to thinking whenever one is interested in checking the quality of reasoning about a problem, issue, or situation" (para. 1). Daily practice and modeling is required by the teacher to ensure that students are learning the universal intellectual standards to improve their critical thinking skills (Paul & Elder, 2010). As Paul and Elder (2010) explained, it is the responsibility of the teacher to ask questions that encourage students to think critically. These questions need to done routinely by the

teacher, therefore, allowing students to automatically develop questioning skills that lead the student on the correct path for seeking in depth solutions to problems (Paul & Elder, 2010).

Marin and Halpern (2011) and Reid and Anderson (2012) studies both echoed the same concern that students need to practice using critical thinking skills so that they become accustomed to implementing higher order thinking effectively and efficiently when warranted and it should occur spontaneously. Marin and Halpern's (2012) study in a high school setting wanted to "compare both imbedded (implicit) and explicit methods of critical thinking instruction and the effects of each method on the ability of students to transfer critical thinking to a wide variety of everyday situations" (p. 2). Reid and Anderson's study embraced a curriculum devoted strictly to teaching critical thinking to 34 business college students. In conjunction with the critical thinking skills lessons, these students were instructed to conduct a case study of a corporation. The purpose of Reid and Anderson's (2012) case study project was to determine if students would transfer critical thinking skills learned throughout the course (i.e., different domain) within their case study project. The results from both Reid and Anderson, as well as, Marin and Halpern's studies confirmed what Paul and Elder (2010) have stated that daily practice and reinforcement of critical thinking skills are essential for how to think critically. Marin and Halpern's study discovered that high school students who received explicit instruction for learning critical thinking skills showed improvement compared to students who received implicit or embedded instruction of critical thinking skills. Whereas, Reid and Anderson's study determined that critical thinking is able to be taught, learned, and

applied to another domain which increases students' academic learning. Both of these studies emphasized the importance of implementing critical thinking skills within the curriculum on a daily basis. Halpern (1998) discussed the importance of not just teaching students how to think critically, but allowing them real-life experiences that teach them when and how to implement particular skills of higher order thinking. Students need the practice and time to experience metacognition (i.e., thinking about your thinking) (Halpern, 1998; Marin & Halpern, 2011; Paul & Elder, 2010; Reid & Anderson, 2012).

Increasing students' opportunities to practice questioning that apply to the universal intellectual standards of clarity, accuracy, precision, relevance, depth, breadth, logic, significance, fairness, and depth will allow students to increase their critical thinking skills. Students who are able to ask important question and seek answers on their own become good at reasoning. Shim and Walczak (2012) conducted a study at the college level to determine the impact of teachers' instructional practices has on students' critical thinking skills. Their study revealed that projects and presentations had a negative effect on critical thinking which is surprising because normally projects and presentations have been proven in past studies to have a positive effect on critical thinking (Shim & Walczak, 2012). Those negative teacher instructional practices include creating projects and presentations (Shim & Walczak, 2012). While this contradicts project-based learning, it also highlights an important fact that different teaching practices need to be implemented according to students' cognitive development because first-year college students are more dependent on teacher as the provider of information instead of working with peers to seek answers and information (Skim & Walczak). An important result from

Skim and Walczak's (2012) study is that students increase their understanding and knowledge of critical thinking skills when the teacher ask challenging questions, provide frequent explanation to abstract concepts, and conducts well organized presentation of new information. These important components found to increase students' critical thinking skills and need to be implemented often throughout the lesson so that students are challenged to think critically.

Paul and Elder (2008a) concurs with Skim and Walczak's (2012) study when they noted that students need to be able to use the universal intellectual standards questions automatically when students encounter problems and they are having to seek solutions for that problem. Elder (2004) emphasized that "the human mind, without discipline and rigor, is prone to shoddy thinking" (para. 4). Therefore, it is essential for educators to have learning models that allow students to practice challenging questioning that assist in improving their critical thinking skills. Paul-Elder's model of critical thinking (2008b) supports constructivist learning because the learners think about their learning as they are actively participating in their intellectual development of thought.

The American Philosophical Association Delphi Report (Facione, 1990) included experts of critical thinking in a highly detailed report that set the stage for the foundation of explanation for describing what constitutes critical thinking in educational instruction and assessment. While there are many definitions of critical thinking, this quantitative research study implemented a Delphi Method with a panel of 46 experts on the topic of critical thinking. It is through this research study that a professional clarity of what comprises critical thinking in educational instruction and assessments (Facione, 1990).

The explanation is lengthy because it includes all the skills and sub-skills required to be a critical thinker (Facione, 1990). The American Philosophical Association Delphi Report (Facione, 1990) is a detailed explanation of critical thinking for educational instruction and assessments. The following is the consensus statement regarding critical thinking and the ideal critical thinker:

> We understand critical thinking [CT] to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based. CT is essential as a tool of inquiry. As such, CT is a liberating force in education and a powerful resource in one's personal and civic life. While not synonymous with good thinking, CT is a pervasive and self-rectifying human phenomenon. The ideal critical thinker is habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit. Thus, educating good critical thinkers means working toward this ideal. It combines developing CT skills with nurturing those dispositions which consistently yield useful insights and which are the basis of a rational and democratic society. (Facione, 1990, p. 3)

Facione's (1990) Delphi report highlighted how important it is for students to learn how to correctly implement critical thinking. Having a learning model that infuses critical thinking and problem-solving into the instruction is essential to the cognitive development in high school students. Getting students to think critically requires a learning environment that ignites the motivation to tackle ill-structured problems while encouraging students to analyze, synthesize, and reflect (Choy & Oo, 2012). More often than not, the learning environment does not allow students the adequate time to do reflective thinking (Choy & Oo 2012).

Allowing students the time to reflect is an essential component for critical thinking. Reflective thought allows metacognition (i.e., thinking about thinking) to transpire. According to Ennis (1996), "Critical thinking is reasonable reflective thinking focused on deciding what to believe or do. The emphasis is on reasonableness, reflection, and the process of making decisions" (p. 166). Dewey (1910) defined reflective thought as, "Active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends" (p. 6). Collier (1999) clarified Dewey's statement by explaining, "Reflective thinking is thought that requires turning an idea over in the mind and giving it serious consideration. Reflection commences when one inquires into his or her experience and relevant knowledge to find meaning in his or her beliefs" (p. 173). Reflective thought is a process that encourages retention of information resulting in understanding of a concept.

Collier's (1999) qualitative study of four elementary preservice teachers during their student teaching experience focused on how these four teachers implemented

reflection of their learning into their teaching. Collier gathered data by having students keep reflective journals, participate in weekly and midterm reflective interviews, critique a peer by visiting the classroom of that peer and recorded observations, and attend three group seminars that focused on reflection. Collier found that these four student teachers had a difficult time activating in depth reflection because these student teachers had a difficult time changing from a student mode to a teacher mode. Therefore, these student teachers forgot to implement in depth reflection while they were learning. Collier's study highlights the importance that as a teacher, learning must guide the teaching and teaching need to include continuous reflective thought.

In Choy and Oo's (2012) mixed-method study of 60 higher education teachers, these teachers completed a 5-point Likert scale questionnaire that looked at how teachers where implementing critical thinking skills while they were teaching. The results of the study found that teachers were not implementing critical thinking skills during their teaching. Interestingly, teachers did not want to reflect on their teaching skills, but were willing to receive some feedback on improving their teaching (Choy & Oo, 2012). It is important for the expansion of critical thinkers in the learning environment that educators need to embrace critical thinking and provide instructional opportunities for students to reflect and think about their thinking. Also, educators need to educate students on how to be critical thinkers by demonstrating critical thinking skills on a daily basis.

In two different studies which consisted of a mix-method pilot of 12 undergraduate and 13 graduate engineering students and a qualitative study of undergraduates, Douglas (2012) found in the pilot mix-method study that it is difficult to

measure critical thinking with just one type of instrument and he questioned if any particular measuring instruments can actually measure critical thinking thoroughly. Also in the qualitative study, students varied on their conceptualization of critical thinking which created a discrepancy between those who believed they were implementing critical thinking skills and those who were not. The result of these two studies by Douglas highlighted that undergraduate students tend to choose an answer if they cannot solve the problem compared to graduate students who tend to think through and try to answer the question. Consequently, different levels of educational experiences have an effect on how a person implements critical thinking skills which is important for educational systems to be cognizant of when designing instruction that requires students to think critically.

Experiences and knowledge are critical to reflective thinking; therefore, educational learning needs to include instructional designs that provide a wealth of authentic experiences that emulate real-world situations that requires students to relate new knowledge with past understandings. Piaget (1932) noted the importance of reflective thought in cognitive development. Also, Piaget reported that developing the skills for reflective thinking is one that takes practice and time. It is through project-based and problem-based learning that students are encouraged to develop the skills for reflection of their work. One important skill that results from the implementation of reflective thinking is metacognition (i.e., thinking about thinking).

Ku and Ho's (2010) study highlighted the importance of using metacognitive strategies in critical thinking. Ku and Ho's study used 10 high performing university students who had different levels of critical thinking abilities. A think-a-loud was used to

verbally hear the thinking processes of these 10 students. Their findings concluded that students with high levels of critical thinking abilities implemented strategic plans of how to complete the task, confirmed their understanding of the task by using self-monitoring strategies, and evaluated their own thinking and reasoning during the activity. Ku and Ho's (2010) study highlighted the importance that students who have gained the ability to think critically need to be challenged in learning environments that encourages them to implement metacognitive strategies. Ku and Ho's study points out that when teaching students to be critical thinkers they need to learn how to think about thinking.

In a project-based learning atmosphere, the students have the opportunity to review problem-solving methods used during the project, which allows students to adjust their metacognitive strategies for the completion of the project. When reflective thinking is part of the instructional design in a true constructivist learning environment, there is allocated time for in depth analysis to occur. Students are able to test, evaluate, and refine their solution before they have to defend their final project. It is during this time period, students are implementing critical thinking, collaborating with their peers, researching solutions, and thinking about their thinking (i.e., metacognition).

Traditional classroom lessons are tailored to a specific time period with precise questions to be solved. This places limitations on students and the methods of how to solve problems as well as stifles higher order thinking. The goal of education is the retention of concepts learned. However, to ensure retention of concepts, students' must take ownership of their learning. Allowing students to seek answers in multiple learning opportunities encourages students to develop in depth understanding and knowledge of

the problem. Scott (2010) defined reflection as "the process or means by which an experience, in the form of thought, feeling, or action, is examined to distill its meaning while it is happening or subsequently" (p. 432). Scott (2010) discovered that students do not have the opportunity to reflect on the task or problem they have been presented to complete or solve in a learning environment. Therefore, learning models should have within their instructional design more reflection opportunities whether it is in the form of a journal, learning portfolio, or daily discussions so that in depth thinking occurs. Scott's study centered on how learning portfolios improve reflection skills and discussed the value of learning portfolios, which provides the students the opportunity to reflect on their learning as well as allows teachers the opportunity to provide feedback on the progress of the students' learning.

When solving a problem, reflective thought and thinking critically are necessary components for seeking a solution to the problem (Scott, 2010; and Sullivan, 2012). In Sullivan's (2012) study of nursing students, students who thought they were implementing critical thinking skills were actually not implementing the correct methods for critical thinking; therefore, they were not thinking critically. Whether a nursing program or a CTE program, teaching students the proper way to think critically is the missing component found in many academia learning models. Time, practice, and having a variety of opportunities to implement critical thinking are the key elements needed to become a critical thinker (Sullivan, 2012). Students who lack critical thinking skills need to have teachers who are correctly demonstrating and providing instructional strategies

that allow students to develop the process to think critically (Choy & Oo, 2012; Joseph, 2010; Sullivan, 2012).

Choy and Cheah's (2009) qualitative study in Malaysia concluded that higher education teachers who participated in their study did not have a solid understanding of critical thinking as well as the required understanding and knowledge of how to effectively implement critically thinking. Their study pinpoints that educators are not versed in using and implementing critical thinking skill which is an important issue faced in classrooms across America. As reported in Choy and Cheah's (2009) study and Flores, Matkin, Burbach, Quinn, and Harding's (2012) study also reported that many educators believe they are teaching critical thinking skills to their students when in fact they are having the students thinking harder trying to regurgitate the vast amount of material that has been imposed with new content standards. Flores et al. (2012) noted that complicated thinking is not the result of trying to think harder by digesting a vast amount of information, but can be achieved when a person is made to think harder (i.e., more in depth). Stedman and Adams (2012) further confirmed that educators in their research study did not have a solid grasp on how to correctly implement critical thinking skills; even though they thought they were providing their students opportunities to practice thinking critically.

These studies indicate that educators are not adequately training their students to think critically in spite of the massive amount of content information being taught. As Flores et al. (2012) noted, education alone will not necessary guarantee a person will improve in their thinking. Since learning is a process to acquire knowledge and

understanding, it is imperative that teachers know how to implement critical thinking skills. It is the teacher's responsibility to instruct, demonstrate, and allow students to practice critical thinking skills throughout their instruction (Stedman & Adam, 2012). Therefore, having a structured learning model that embraces the components of critical thinking fosters successful learning (Stedman & Adam, 2012).

Problem-Solving

The workforce of the 21st century has limited training in how to solve ill-structured or wicked problems. Jonassen (2004) defined ill-structured problems as problems that are real world problems that people experience on a daily basis and they are not well-structured problems. Jonassen (2004) continued to explain that ill-structured problems are "also known as wicked problems, these problems do not necessarily conform to the content domains being studied, so their solutions are neither predictable nor convergent" (p. 3). When students are able to gain experience, collaborate, and reflect on their learning, they become experts of their learning as well as effectively and efficiently solve wild and/or wicked problems. Incorporating problem-based learning into the learning process encourages students to gain valuable experience in problem-solving in a collaborative atmosphere.

Technology has allowed people to gather, share, and create a vast amount of information. Additionally, this information can be analyzed, synthesized, and evaluated into multiple aspects. Students of the 21st century must have the skills to be able to engage in higher order thinking to utilize this information. Training students on how-to problem solve complex problems begins early in the educational process. Unfortunately,

students are receiving training in the wrong type of problem solving. Students are taught well-structured problems instead of ill-structured problems found in real-world work environments (Laxman, 2010).

Teachers are the key to ensuring that students receive learning opportunities that allows students to engage in problem-based learning that reinforces how-to solve complex and ill-structured problems. Hooking the student with authentic problems establishes that learning is important and relevant to them. The teacher's pivotal role is to tell the student the problem and the classroom needs to be conducive for students to explore, test, evaluate, and seek multiple understandings of the problem. Unfortunately, many classrooms in American public schools do not lend themselves to this type of learning environment.

As technology continues its rapid change in this global society, American public schools must seek to realign its curriculum to include increased collaboration, adaptability, innovation, and the opportunity for reflection of the material being learned. Students will need to demonstrate their mastery of concepts and their ability to think outside the square box. Gaining experience in collaborating with others, adapting to solving ill-structured problems, increasing critical thinking, while demonstrating mastery of concepts are a few prominent features found in a problem-based learning environment.

Traditional Learning

There is a major difference between constructivism and the learning environment that most secondary educators implement which is known as traditional education or didactic instruction. Nie and Lau (2010) explained that didactic instruction is the

complete opposite of constructivist learning because students in a constructive learning environment are active participants in their learning compared to a didactic instruction where students are sitting passively receiving instruction. Didactic instruction is another term used for traditional behaviorist instructional method and in this learning environment the teacher is the giver of information (Nie & Lau, 2010). The teacher is often in front of the class lecturing; therefore, implementing anything contrary to this method is often viewed by the teacher as a distraction or not as valuable as what they have to say.

A study conducted by Nie and Lau (2010) focused on ninth grade Singapore students' achievement for learning English in constructivist and didactic instructions, they discovered students who participated in a constructivist learning environment displayed higher cognitive development, increased their motivation to learn, and improved academically compared to students who participated in a didactic learning environment. Furthermore, Nie and Lau's (2010) study included ninth grade students as raters and found that using these students as raters were valid and reliable. Allowing students to participate as raters provided an in depth analysis of their understanding of a constructivist and a didactic instruction. Students were able to distinguish between a constructivist and didactic instruction; therefore, they favored constructivist instruction because students experienced learning opportunities that were more meaningful and interesting to them. Nie and Lau's (2010) study highlights the importance of making learning engaging that has real-world connections. As Nie and Lau (2010) explained,

constructivist instruction engages students in their learning while providing a foundation for students to gain understanding of their learning.

A case study of computer student teachers conducted by Basbay and Ates (2009) supported the findings of Nie and Lau's (2010) study. Basbay and Ates' case study revealed that constructivist project-based learning incorporated many skills as well as collaboration, self-reflection, research skills, and problem solving. Keeping students interested in their learning is a key benefit of a constructivist project-based learning instruction. Students voiced how they were able to learn from the experiences that they encountered and construct new knowledge and understanding based on the hands-on approach allowed by a constructivist learning environment (Nie & Lau, 2010). Establishing the right atmosphere for learning prevents a student from becoming bored which often limits and/or stifles learning (Nie & Lau, 2010).

Traditional education has remained the basic format of education and the obstacles to reform education have been a daunting task. While cognitive development remains a central concern for educational leaders, administrators, educators, and parents; there has been limited amount of change in the methodology for enhancing cognitive development in the learning process. An obstacle that limits the opportunity to educate students in a highly engaged and active learning environment is the instructional learning environment taught to numerous students across America.

Dr. John Dewey, an educational theorist of the early twentieth century, wanted to reform the educational system to one that mimics the real-world (Dewey, 1920). Authentic learning was his goal for American education, but reforming this large

educational system became impossible. Dewey (1916) could not reform the traditional educational method to allow for more active learning because traditional passive learning was viewed as the finest method for educating large masses of students. Dewey further explained, “Education is not an affair of 'telling' and being told, but an active and constructive process, [which] is a principle almost as generally violated in practice as conceded in theory” (Dewey, 1916, p. 46). Dewey’s frustration is apparent in his statement and consequently, this same frustration appears in education a century later.

The educational structure of the traditional school is still the dominant structure in many schools nationally and even globally where learning is passive and relies mostly on rote memorization of facts (Michel, Carter, & Varela, 2009). In addition, schools treat each subject matter as an isolated entity. According to Dewey (1916), this was not how education should be structured and taught. As a constructivist theorist, Dewey knew how students should learn but convincing the educational system to embrace a new and different paradigm had many roadblocks.

A passive learning environment does not encourage students to take ownership of their learning which reverberates into the future work ethics of these passive learning students. A workforce containing passive workers is not productive and lack enthusiasm toward their job. A workforce with active workers is highly productive because these employees seek to solve complex problems, are more innovative, and are more excited to work collaboratively to maintain a robust working environment. Michel, Carter, and Varela (2009) conducted a quantitative research study of approximately 7,000 business students to determine if cognitive development was enhanced by implementing active

learning over passive learning. Their study revealed that active learning is not better or worse than passive learning. Students had much higher cognitive outcomes on specific concepts with active learning compared to passive learning (Michal et al., 2009). Their study reiterates Dewey's belief that active learning motivates and engages students which then encourages cognitive development to occur.

In the last century, there has been little change in curriculum, methodology, and evaluation within the American public school system. The stresses of a weak economy and high demands of the workforce are forcing schools to overhaul a system that is outdated and underperforming (Flores, Matkin, Burbach, Quinn, & Harding, 2012; Halpern, 2012; Symonds, 2012). The probe method (PM; Shepherd, 1998) theoretical framework is based on constructivism which encourages an active learning environment where the teacher is the guide not the presenter of the concepts to be learned. In the PM, students are the seekers and analyst of the information as well as managers of how the complex problem will be solved. Students are highly engaged in all levels of the stages throughout the PM and they are makers of all decisions, not passive learners waiting for the teacher to provide the entire concepts to be learned.

CTE

CTE programs allow students the opportunity to become active members in their learning process. Similar to what Dr. John Dewey's envisioned educational programs to encompass; CTE programs are the closest educational program structure that allows skills, real-world experiences, and concepts to be interwoven into the learning process. CTE students taught in a constructivist project-based learning environment often display

engagement and excitement because they are active participants while developing skills that promote active and self-directed learning (Hubbard, 2012). According to Kelly and Price (2009),

> On average, ten different vocational programs are available to students; six on-site and four off-site, with 83% of high schools offering programs on-site. Typically, programs without specialized facilities, such as business and technology programs, take place on-site while programs such as mechanics, construction, and health care, are taught off-site. ..[c]omparatively, less than 30% of private schools offer vocational programs (p. 811).

Recently, there has been an increase in magnet schools that implement CTE programs with core academics. As Kelly and Price (2009) further stated, "There are an additional 5% of 'full time' career and technical high schools that teach academics through a career and technology focus, such as engineering technology magnet schools" (p. 811). Even though there seems to be a large number of high schools offering CTE programs, there are many schools and students who do not benefit from the active learning that is available through these programs. Consequently, a large number of students do not get to experience the benefits of a CTE program that promotes active constructivist learning.

CTE programs are the closest learning environments that mirror Dewey, Piaget, Papert, and Vygotsky's vision for active learning in public education. The RQs for this study are based on a CTE learning environment and how students and teachers perceive the role and function of the PM has on learning in a CTE learning environment.

Technology Integration

Technology integration is a major component of the PM (Shepherd, 1998). Students use of technology to research information about a complex problem and seek answers to how to reach a solution to solving that problem. The technological landscape has changed since the creation of the PM; therefore, literature review of the current trends are discussed to help explaining the most up-to-date technological advancements that are being used in education and how present day students utilize technology.

Societies' love and appreciation for technology has created school systems to look at a new concept known as bring-your-own technology (BYOT) and also known as bring-your-own device (BYOD). The rapid expansion of technological advancements in the last five years is causing educational systems across America to rethink how students have access to technology. Recently, many school systems are allowing BYOT into the classroom which brings the current technology into the learning process. Since many students now own Smartphones, iPads, and tablets, it is only reasonable and feasible to allow the most technological savvy generation to use technology to assist in their learning.

Gikas and Grant (2013) investigated how mobile devices were used in learning via the student perspective by conducting a qualitative study. There were nine college students and three professors from the United States participated in their study. Gikas and Grant's (2013) study concluded that students favored using their mobile devices for learning despite some obstacles which were technological distractions as well as equipment failures and difficulties. Gikas and Grant (2013) noted that some professors

were not technology enthusiasts and did not integrate technology into their lessons. This created confusion on the part of the student on why some included technology and others did not. According to Gikas and Grant (2013), some professors instructed students to put away their technological devices because the professors did not see the purpose or value of technology as an important component within the student's learning process.

O'Bannon and Thomas (2014) found in their study of 1,095 K-12 teachers from the southeastern United States that the age of the teacher determined if mobile devices were implemented into the learning process. Digital natives is the term given to people who were born after 1980 because they have had digital technologies available to them all their lives whereas anyone born before 1980 as known as digital immigrants (O'Bannon & Thomas, 2014). Teachers who were 50 years of age or older tend to limit or not allow mobile devices within their classrooms whereas teachers who are digital natives and teachers ages 33-49 were more likely to infuse mobile devices within their classrooms. O'Bannon and Thomas' (2014) study reinforces Gikas and Grant's (2013) study that some of the main barriers is not the technology or students lack of having technology, but the educators who lack the confidence with new technology and changing their teaching methodology. In the 21st century, education and technology has many barriers and overcoming those hurdles is part of the growing pains of BYOT, however, educators need not be that barrier when technology is known to be a motivating learning tool within the classroom (Gikas & Grant, 2013). Weaving mobile devices into the learning process allows for students to learn anywhere at anytime (Gikas & Grant, 2013; Thomas & O'Bannon, 2013; O'Bannon & Thomas, 2014). Mobile devices increase

students' ability to communicate, collaborate, and research during their formal learning process and it activates informal learning which is considered to be the motivating aspect of technology (Gikas & Grant, 2013).

The constructivist paradigm merged with technology integration can satisfy the world's demand for effective and efficient workers while creating highly engaging and authentic instruction within the classroom. Having learning models that challenges the learners of the 21st century by requiring students to think critically, solve complex problems, and become motivated self-directed learners is important to the success of the learner as well as society. Incorporating mobile technology into the classroom brings the real-world to the learner instantaneously. As Gikas and Grant (2013) discovered that learning occurs anywhere and anyplace. It does not matter where the student is located for learning to occur. The student needs to be an active participant but not a passive participant during their learning processes. Active real-world experiences are now available to all students just as Dewey, Papert, and Piaget envisioned a decade ago, however, it is now achievable by a completely different method.

Summary

Having new technological options for cognitive development in education encourages engagement of students in the learning process. Yet, limitations of technology integration and the lack of student and educator training curtail the effectiveness and efficiency of instructional delivery into the classroom. For that reason, educational leaders are searching for alternative learning models to accommodate and educate learners of the 21st century. This extensive search to find the right methodology to

capture students has directed educational leaders to examine past learning theories and methodologies for solutions while looking at the requirements for a successful global workforce of the present and future.

Consequently, the gap in the research for this study is that the PM (Shepherd, 1998) showed success with motivating students to learn, increasing critical thinking, and providing a structured lesson that promotes solving complex problems at the elementary grade level; however, the PM has not been studied in a CTE program at the high school level. This study builds upon constructivist theorist Dewey, Papert, and Piaget's theories that indicate that active learning encourages students to think critically, become motivated in their learning and become responsible participants in their learning process. Furthermore, in active learning environments students have the opportunity to work collaboratively to solve complex problems as well as provide the time to reflect on their learning. Changing from a traditional didactic instructional format to a constructivist learning environment allows students the opportunities to experience authentic real-world problems while providing the skills needed to tackle those problems both individually and collaboratively.

The PM (Shepherd, 1998) structure is based on project-based and problem-based learning strategies which are active constructivist learning environments. Chapter 3 of this study will explore the role and function of the PM on students' motivation to learn and critical thinking in a high school CTE classroom. The literature provided in this study help understanding the direction that high school students need to pursue to be successful in the global workforce and how important it is to gain the skills needed to be a self-

directed learner. For a student to be a self-directed learner, they need to have lessons that are engaging and provide the opportunities to challenge them to think critically and solve complex problems without guidance. Teachers need to have researched learning models that are proven to be successful in providing students the necessary skills needed to be successful employees and citizens in the 21st century.

Chapter 3: Research Method

Introduction

This study explored how the PM learning model (Shepherd, 1998) impacted high school students' motivation to learn and their critical thinking skills while they were participating in a CTE program. For this research study, a case study was chosen to investigate effectiveness or ineffectiveness of instructional strategies employed in the PM that impacts students' motivation to learn and to think critically. Limited research had been conducted on learning models in high school CTE programs. This case study attempted to provide an in depth description of how the PM engages students in their learning process and infuses critical thinking skills.

The single case was the PM in a high school CTE program. The PM was chosen because of the success it had with students' motivation to learn and their ability to think critically in a constructivist learning environment at the elementary level. The gap in research was that the PM (Shepherd, 1998) had not been researched at the high school level in a CTE program. I wanted to see if the PM was a successful learning model that would impact students' motivation to learn while at the same time improving their ability to think critically.

Five major sections are addressed in Chapter 3. The first section includes the explanation and rationale for choosing a qualitative case study. The second section discusses the role of the researcher, her relationship to the participants, and her relationship to the instructor. The third section 3 features an in depth explanation of the methodology, a detailed description of the context of the study (i.e., setting), and

justification for the population size and the selected participants. Section four contains an explanation of the data analysis plan, which explains the different types of data that was collected. Finally, the fifth section describes the issues and procedures that were followed to guarantee trustworthiness and ethical treatment of human participants and material used in the study.

Research Design and Rationale

Research Paradigm

The research paradigm chosen for this study was the qualitative method. Creswell (1998) stated "Qualitative researchers approach their studies with a certain paradigm or worldview, a basic set of beliefs or assumptions that guide their inquiries" (p. 74). It is this uniqueness that allows different assumptions, perspectives, and/or theories to emerge within the qualitative paradigm (Klenke, 2008).

Case Study Research

Creswell (2009) stated that "Case studies are a strategy of inquiry in which the researcher explores in depth a program, event, activity, process, or one or more individuals" (p. 13). A case study strategy is chosen for this study because it will allow the researcher to investigate and explain in depth how the PM impacts students' motivation to learn and higher order thinking skills while participating in a high school CTE program. Stake (1995) highlighted that a "case study is the study of particularity and complexity of a single case, coming to understand its activity within important circumstances" (p. xi). The complexity of this single case was the PM (Shepherd, 1998) that was located in a particular high school CTE program.

By doing a qualitative study, the researcher tries to gain knowledge, understanding, while looking at different points of view about a specific phenomenon (Merriam & Associates, 2002). The perspective of high school students in a particular CTE program assisted in understanding the processes of the PM (Shepherd, 1998) and aided in determining whether the PM was effective at the high school level in a CTE program. The PM (Shepherd, 1998) is a phenomenon that was analyzed by using individual feedback of a CTE classroom in a high school setting.

Yin (2009) defined a case study as "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (p. 18). Also, Stake (1995) noted that a case study's characteristic is to examine the intricacies of a single phenomenon. The PM (Shepherd, 1998) is the phenomenon that was researched in this study and as the researcher, I used a variety of data from various amount of data sources to explain the contextual aspects of the case that might not be apparent to a classroom teacher.

Possible Other Designs

There were several different qualitative designs that were considered for this study but were rejected because the case study allowed in depth analysis of a small group of people in a particular situation within its natural setting. The researcher of this study rejected ethnography design because behaviors of a group with similar cultures were not part of this study. Also, a grounded theory study was rejected because in a grounded theory design a theory is developed from a specific process (Creswell, 2009). In this case

study, the PM (Shepherd, 1998) was based on the constructivist theory; therefore, a theory did not need to be developed. The phenomenological design was considered because a phenomenological study seeks the perception of a person and tries to gain understanding of the person's perspective to that issue (Leedy & Ormrod, 2005). However, lengthy interviews are required as part of a phenomenological study and this is not suited for a high school setting or this study.

Research Questions

The following questions are the specific RQs that will be addressed:

1. How does the PM impact high school students' motivation to learn when implemented in a CTE program?
2. How does the PM impact high school students' critical thinking skills when implemented in a CTE program?
3. How does the teacher perceive the PM as a means to motivate students to learn in a high school CTE program?
4. How does the teacher perceive the PM as a means to engage student in critical thinking skills in a high school CTE program?

Role of the Researcher

The role of the researcher in a qualitative research study plays a pivotal part in the research. Creswell (2009) explained that the role of the researcher in a qualitative study is unique because a qualitative researcher is able to present untainted issues that only pertain to the phenomenon being studied. Additionally, the qualitative researcher is able to capture real world experiences through their observations and data collections because

they are collecting this information first hand from the participants (Merriam & Associates, 2002). Qualitative research is known as interpretive research because of the researcher's ability to work with participants and interpret what has been collected and observed (Creswell, 2009). My role as the researcher in the data collection process for this case study was that of an inquirer and analyst. Also, my roles included conducting interviews as well as analyzing surveys and interviews.

Creswell (2009) explained that a researcher needs to disclose any information known about the phenomenon so that there is clarity of the researcher's interpretations about the phenomenon being studied. My role as the researcher was that of an interviewer and interpreter of data of a high school engineering technology CTE classroom. Currently, I am a high school broadcasting/video production teacher whose classroom is across the hall from the engineering technology classroom. There could be some students whom I have taught in the past which might bring certain biases to this study. However, I did not have power over these students other than my authority of being a teacher at this high school which requires me to address issues that an educator employed at this high school would address (i.e., safety, discipline, suspicious activity etc.).

I have known the participating teacher in this case study for 14 years. I first met this teacher 14 years ago while teaching at the same elementary school. I taught fourth grade and she taught fifth grade. We both taught mainly science and math, but have taught all subjects required at the elementary level. Additionally, we took the same online Master's Degree program, worked on numerous science and technology committees throughout the years, attended the same Gifted Endorsement course taught and paid for

by our school district, and we both have our technology education certification for middle and high school.

The reason for wanting to conduct this case study in the engineering technology classroom is that I believe the participating teacher has the experience and knowledge of how to teach in an authentic constructivist project-based learning environment and knows how to implement problem-based learning. Also, her background with teaching critical thinking skills, technology, and problem solving provides the necessary requirements needed to implement the PM (Shepherd, 1998). However, having a long professional relationship with the participating teacher may bring certain biases to this study. I am aware that there could be potential for bias on my part because of my long time working relationship with the teacher in this case study; however, I will make every effort to counteract these biases.

Context of the Study

Setting

A high school CTE engineering technology classroom was the site for this case study. This high school was five years old and featured all the necessary technological advances of a 21st century classroom. This classroom had a mixture of ages, gender, and ethnicities commonly found in a regular public high school CTE setting. The grade levels that attended this course was 9th grade through 12th grade. Since this was an introductory class for engineering technology, there should be more 9th and 10th graders than 11th and 12th graders.

Students had to research, design, and build a finished product as they proceed through the requirements of the PM (Shepherd, 1998). The focus was on the researching, designing, and constructing a paper roller coasters that meet certain criteria while following the engineering design process. Yin (2009) noted that a product is not relevant in a case study, however, there are times a physical product can be significant to a case study. This finished product indicated that students were motivated to learn which promoted them to implement critical thinking to create an accurate replica of their paper roller coaster design resulting from the research collected and analyzed about Newton's Laws of motion, Law of conversation of energy, centripetal force, acceleration, and friction.

This classroom is equipped with computers for each student to use for their research and design. Materials will be provided by the school so students can complete their finished product. This classroom has a large storage room to house their projects. There is a conference room in the front office where student interviews can take place.

Participants

The participants consisted of 17 high school students. There were 13 males and 4 females between the ages of 14 and17. These students were placed in an Introduction Engineering Technology class according to their choice of 5 elective courses of interest and the availability of those choices for a particular time period on their schedule. This particular classroom is equipped with 30 student computers; therefore, up to 30 students can attend this class. There was only one teacher for this study and this teacher taught three Introduction Engineering Technology classes throughout the day and one Graphic

Design class. For this study, only one of these three Introduction Engineering Technology classes participated in this study.

The participating teacher has been teaching for two years at the high school level, but has taught at the elementary level for 12 years. The teacher and researcher both attended the same Gifted Endorsement course and obtained gifted certification. During the Gifted Endorsement program, critical thinking was covered in depth and both the participating teacher and the researcher had to implement critical thinking lessons within their own classrooms as part of the course requirement.

Ethical Consideration

This study protected the rights of human subjects which include the teacher and students. The research followed all guidelines established by the Institutional Review Board (IRB) of Walden University as well as the guidelines required from the school district in which this study will take place. The approval number from Walden University IRB was 06-30-14-00107061 for this case study. Yin (2009) stated, “The board [IRB] is charged with reviewing and approving all human subjects’ research before such research can proceed” (p. 74). All candidates were provided a parental consent invitation letter and all candidates who are under 18 were given an assent form of research to participate in this study. In addition, the participating teacher was given a teacher consent invitation letter and all student participants over 18 were given a consent form. A letter of cooperation was given to the participating school district (where the researcher is employed) and a request to coordinate the data was given to the school.

All students and teacher information was kept confidential. I took great care in making sure that all materials and information followed the guidelines set forth by Walden University and the school district policies set forth for research methods of their students and faculty.

Sampling

A purposeful sampling occurred when six students was selected to be interviewed among 17 student participants. Merriam (2009) noted that purposeful sampling occurs when the researcher is wanting to obtain the greatest insight of the phenomenon by selecting the best participants. The purposeful sampling for this case study will be a range of participants who were high, medium, and low performers during the implementation of the PM (1998). The researcher was given permission by the school administration to access the student grades for this project by providing a letter of cooperation addendum. The researcher selected two students from each category who's grade performances were high, medium, or low scores from the Introductory engineering classroom which used the PM to research, design, and construct a paper roller coaster for the student interviews.

Data Sources

This case study started with the investigation of how the PM (Shepherd, 1998) impacts students' motivation to learn and critical thinking skills, by using four data instruments. These instruments include archival records of student surveys, archival records of student reflective journals, student interviews, and teacher interview.

Archival Records

In this case study, archival records included student surveys and student reflective journals. These items were part of the PM (1998) lesson that had been conducted in the introduction engineering technology class and was used as data sources for this case study. Yin (2009) explained that archival records are another type of data source used in gathering information for a case study.

Student Survey

A 12-item 5-point Likert Scale survey (see Appendix B) that aligned with the Introduction Engineering Technology PM (1998) lesson was used for the student survey. Questions 1 through 6 were positive worded statements and questions 7 through 12 were negative worded statements. McNabb (2010) noted that the Likert scale measures a respondent's agreement or disagreement to the item being asked. This student survey was used to measure student's motivation to learn while using the PM (Shepherd, 1998) in a project-based learning environment that infuses problem-based learning to motivate students to learn and think critically.

Student Reflective Journal

Archival records were collected from the student reflective journals that pertained to only the PM (Shepherd, 1998) lesson. Students are required in the Introduction Engineering Technology class to keep an electronic engineering notebook that requires them to periodically reflect on their work assignments when instructed by the teacher. These journals were kept on each of the students' computers and located in a Microsoft Word document file folder. The teacher required students to reflect during the mid-point

and end of the PM and provided students with targeted areas for reflection (see Appendix C). The reflective journal assisted in determining if students were motivated to learn during the PM lesson. Givens (2008) implied that journal writing is a valuable piece of data material because it allows the participants to express their thoughts in more private manner.

Interviews

Interviews are an integral part of case study (Yin, 2009). I conducted a semi-structured individual student and teacher interview. A semi-structured interview design has flexibility and is not as rigid as a highly structured interview design where the researcher must keep the interviewee responding to the specific question asked (Hesse-Biber & Leavy, 2010). Furthermore, Hatch (2002) highlighted the importance of using open-ended questions to encourage the participants to share their knowledge and understanding of the phenomenon during a formal interview. Student and teacher interview questions were all open-ended and were designed to encourage participants to share their information about the phenomenon which was being studied.

Student Interview

The student interview questions (see Appendix D) consisted of 11 open-ended questions that encouraged the interviewee to feel comfortable to express their thoughts about the phenomenon. Some sample questions were:

- What are your thoughts about the PM motivating you to learn?
- What are your thought about the PM helping you to think critically?
- What types of problem solving strategies did you use to solve your problem?

It is important that the researcher can rely on participants who have in depth knowledge and experiences about the phenomenon (Rubin and Rubin, 2005). According to Hesse-Biber and Leavy (2010), when a semi-structured interview data collection is implemented the researcher should allow the flow of conversation to occur naturally and without interruptions. As the interviewer who has professional experience working with high school students, I kept the student focused on the topic of the question while allowing latitude for the student to freely express their knowledge and understanding of the question presented to them.

Teacher Interview

Interviews are significant to a case study because they bring a human and/or behavioral aspect to the study (Yin, 2009). The teacher's interview questions (see Appendix E) consisted of 11 open-ended questions. The teacher's interview questions focused more on the of the role and function of the PM and these can be implemented as a means to engage students in critical thinking skills, increase students' motivation to learn, and in getting students to solve complex problems in a high school CTE program. Some sample questions were:

- Did the PM help motivate students to learn? Why or Why not?
- Did the PM help students to think critically? Why or Why not?
- What kind of critical thinking strategies did you implement when designing and building the paper roller coaster?

Procedures for Data Collection

Data collection procedures included four methods of data collection. The four methods of data collection were archival records of student survey, student reflective journals, student interviews, and the teacher interview. The paper roller coaster lesson that implements the PM (Shepherd, 1998) learning model took 16 days in the Engineering and Technology classroom.

Archival records were the student surveys that were given on the last day of the PM (Shepherd, 1998) lesson by the teacher. Students provided their perspective of the PM by answering 12 questions on a 5-point Likert scale survey. This survey allowed the researcher to collect data on how students perceive the PM. The other archival records were the students' reflective journals. These journals were typed in a Microsoft Word document and stored on the student's computer. Each student had her own login to secure files and programs. These digital journals were completed when instructed by the teacher at the mid-point and end of the PM (Shepherd, 1998) lesson. Students were given a number instead of naming their files. The researcher uploaded these reflective journal files to a flash drive used only for this case study.

There were six purposeful-sampling student interviews that took place at the end of the lesson and students were interviewed individually by the researcher. These interviews occurred in the conference room located in the front office. This allowed students to have privacy when responding to questions asked by the researcher. The duration of this interview depended on how long the six students provided explanation to

the interview questions. The student surveys, students' reflective journals, and student interviews assisted in answering the RQs 1 and 2.

Finally, the teacher's interview was conducted after school at the end of the lesson. The duration depended on how much information was provided by the teacher. The teacher interview answered RQs 3 and 4.

By using multiple data collection methods, triangulation of data sources occurred. Yin (2009) expressed that a case study allows various types of data collection which helps to legitimize the case. This case study employed data triangulation to validate the data collected (Denzin, 2009). Furthermore, member checking for transcript verification was provided to participating members once the data source material was transcribed by the researcher (Pitney & Parker, 2009). The participating members had the opportunity to review the transcribed material to locate any mistakes in the transcriptions and inform the researcher so corrections could be made (Pitney & Parker, 2009).

Data Analysis Plan

In the student survey, there were six positive and six negative statements used for this 5-point Likert scale. Kelley (1999) explained that when negative statements are included in a 5-point Likert scale instrument, it helps preventing someone from just answering all questions exactly the same (e.g., circling of the five's on the Likert scale). These negative statements were reversed scored because they are the opposite in meaning to the positive statements (Kelly, 1999). As an example, a student circled a "4" (*Disagree*) for a negative statement question then this particular questions it will be

reversed scored as a “2” (*Agree*) instead of a “4” (Kelly, 1999). Students’ responses to the survey were calculated by using descriptive statistics.

Data analysis for this case study also used the inductive coding process. Thomas (2006) explained that inductive analysis uses raw data to achieve reliable and valid interpretations of the results. The students’ reflective journals were imported from a word document which was text based. I also recorded and transcribed verbatim all student and teacher interviews into text by using Word Document voice recognition. After all the data was transcribed, I used Nvivo 10 software to conduct the inductive coding process. I used content analysis with open coding to find categories and themes within the current data. Klenke (2008) expressed that the use of open coding allows the researcher to articulate data into an understandable format. In my data analysis plan (see Table 1), I refer back to the RQs and categorize the content to the relevancy of the RQs (Klenke, 2008).

Once I had collected the data from the archival records of the student reflective journals as well as student and teacher interviews, they were coded to find emerging themes using the Nvivo 10 qualitative data analysis software program.

Trustworthiness

Credibility or the trustworthiness was established by implementing the processes of triangulation and member checking. Triangulation addresses internal validity or credibility and occurs when there are multiple sources of evidence collected for the same case study (Yin, 2009). I triangulated the student and teacher interviews, and archival records of the student surveys and student reflection journals to provide trustworthiness to the study.

Member checking added an additional reinforcement to the credibility of this case study. Stake (1995) described member checking as the process where participants of the study have the opportunity to see their material and make necessary changes if needed. I provided the opportunity for my participants to review transcriptions of all materials that were pertinent to them and no adjustments were needed.

Table 1

Data Analysis Plan

Research Question	Data Collection Tools	Data Analysis
1. How does the PM impact high school students' motivation to learn when implemented in a CTE program?	Student Survey Student Interview Student Reflective Journal	Descriptive Analysis Content Analysis Open coding
2. How does the PM impact high school students' critical thinking skills when implemented in a CTE program?	Student Survey Student Interview Student Reflective Journal	Descriptive Analysis Content Analysis Open coding
3. How does the teacher perceive the PM as a means to motivate students to learn in a high school CTE program?	Teacher Interview	Content Analysis Open Coding
4. How does the teacher perceive the PM as a means to engage student in critical thinking skills in a high school CTE program?	Teacher Interview	Content Analysis Open Coding

Dependability

Ensuring that a study can be easily replicated refers to its reliability (Merriam & Associates, 2002). Yin (2009) further explained, "The general way of approaching the

reliability problem is to make as many steps as operational as possible and to conduct the research as if someone were always looking over your shoulder" (p. 45). Documentation of all the steps and procedures conducted in this study was essential for guaranteeing that this same research study could be replicated if a researcher wanted to conduct this case study in the future (Yin, 2009).

The reliability (i.e., dependability) strategy that was implemented was an audit trail. An audit trail described how the study was conducted so that anyone who wants to perform this study will be able to do so because they have the most accurate information able for them. Merriam and Associates (2002) explained that "an audit trail is dependent upon the researcher keeping a research journal or recording memos throughout the conduct of the study" (p. 27). As the researcher, I kept a research journal and memos that captured all the specific details of conducting this case study.

Summary

Chapter 3 described the research paradigm and research design that were used for this study. Explanations and rationales for choosing a qualitative case study research design were presented along with the role of the researcher, the researcher's relationship to the participants and instructor. In this chapter, in depth explanation of the methodology was provided, detailed description of the context of the study (i.e., setting) was explained, and justification for the participants' selections and population size were clarified. Additionally, Chapter 3 described data collection instruments and data sources that were used, as well as detailed explanation of the data analysis plan. Finally, specific

descriptions of the issues and procedures were provided to explain the trustworthiness and ethical treatment of human participants and material used in the study.

Chapter 4 will present the data results that was collected from the four data sources used to address the four RQs for this case study. This chapter will discuss the setting and explain the conditions of the learning environment, the demographics of the classroom, the types of data collected, the number of participants, and the data analysis process used to determine its themes. Also, trustworthiness and dependability will be explained for this qualitative case study.

Chapter 4: Results

Introduction

The purpose of this qualitative case study was to explore the role and function of the PM (Shepherd, 1998) as an instructional model for addressing motivation to learn and critical thinking among high school students in a career and technical (CTE) program. This case study was designed to examine how the PM impacted high school student's motivation to learn and critical thinking skills while in a CTE program. To achieve this purpose, analysis methods of qualitative inductive coding and content analysis were used to find overarching themes and patterns from the teacher interview as well as students' surveys, journals, and interviews.

Chapter 4 discusses the setting that explains the conditions of the learning environment, the demographics of the classroom, the types of data collected, the number of participants, and the data analysis process used to ascertain its patterns and/or themes. I used Nvivo 10 for coding of the data, a computer-assisted qualitative data analysis

software (CAQDAS) that allowed me to organize the qualitative data collections for analysis. Saldana (2013) explained that "the software efficiently stores, organizes, manages, and reconfigures your data to enable human analytic reflection" (p. 28). Since Nvivo 10 is a CAQDAS and cannot conduct analysis of the data, it is an important tool in the researcher's arsenal so themes and patterns are more visible to the researcher. Saldana (2013) stated, "coding is the transitional process between data collection and more extensive data analysis" (p. 5).

During this case study, I used content analysis with open coding to find themes in the data to pinpoint the patterns that emerged from various data sources. Also discussed in Chapter 4 are specific explanations of the implementation of, and/or adjustments to, credibility, transferability, dependability, and conformability—all of which are presented as evidence of trustworthiness. Finally, the data were collected. A summary of the data (a) answer the four research questions and (b) summarize and explain the case study's findings.

Research Questions

This case study and data collection processes were focused on four research questions:

1. How does the PM impact high school students' motivation to learn when implemented in a CTE program?
2. How does the PM impact high school students' critical thinking skills when implemented in a CTE program?

3. How does the teacher perceive the PM as a means to motivate students to learn in a high school CTE program?
4. How does the teacher perceive the PM as a means to engage student in critical thinking skills in a high school CTE program?

Setting and Demographics

A high school CTE engineering technology classroom was used as the site for this case study. This particular high school was 5 years old and had 21st century classrooms. This classroom included a mixture of ages, gender, and ethnicities commonly found in a regular public high school CTE setting. The grade levels that attended this course were 9th grade through 12th grade. Since the learning environment for this case study was an introductory class for engineering technology, there were more 9th and 10th graders than 11th and 12th graders. This class is the first of three courses for the engineering pathway. A pathway requires students to complete three courses and these courses build students' skills from beginner, to intermediate, and finally advanced. These skills are requirements for that particular career field.

This classroom was equipped with computers for each student to use for their research and design. Materials were provided by the school so students could complete their finished product of a paper roller coaster. The teacher provided students with video lessons of how to cut and build specific parts of the roller coaster (i.e., funnels, sharp turns, wide turns, track, beams, supports, etc.) and various videos on concepts that were important to the lesson.

Data Collection

In this case study, four data instruments were employed to investigate how the PM (Shepherd, 1998) impacts students' motivation to learn and critical thinking skills. These instruments included archival records of student surveys, archival records of student reflective journals, student interviews, and teacher interview. Since various data sources were used to increase the reliability and validity of the data, different case study protocols were followed with each data source. Yin (2009) explained that procedures establish the reliability of a case study while providing a roadmap for the researcher conducting the case study. A detail explanation of the data collection protocol is provided for each data source used in this case study.

Even though the same name is used for various data sources, they do not represent the same participant in the student survey, student reflective journals, or student interview. Also, the researcher assigned a pseudonym to the teacher who participated in the interview. These names are used for ease of reading this case. Since the archival data did not have student names, I assigned numbers to these data sources. Once I was done with my analysis, when needed I used the pseudonym for that student number. For example, all participants whose number was one was assigned the pseudonym, Donna, all participants whose number was two was assigned the pseudonym, Jack and so on. The pseudonyms assigned for all 17 participants and teacher in this case study can be viewed in Table 2.

Table 2

Student and Teacher Pseudonyms

Student Number	Student and Teacher Pseudonyms
1	Donna
2	Jack
3	Andy
4	Jill
5	Leo
6	Belle
7	Maggie
8	Cooper
9	Austin
10	Heather
11	Ashley
12	John
13	Tiffany
14	Max
15	Jared
16	Taylor
17	Jodi
Teacher	Ms. Gardner

Student Survey

Student surveys were collected by the teacher at the end of the lesson that incorporated the PM (Shepherd, 1998). These surveys were archival records that the researcher obtained upon the approval from the Institutional Review Board (IRB) of Walden University, which was granted on June 30, 2014 and the approval number was

06-30-14-00107061. There were 17 surveys and they did not have names on them, therefore, they were randomly numbered for ease of inputting and validating the data. Since I was not going to do cross-analyze between students gender, age, or with any other data collection material in this case study, I randomly labeled the surveys S1, S2, S3, etc. Once receiving copies of the student surveys from the teacher, the researcher created an Excel spreadsheet to analyze the data for the surveys. By using the Excel spreadsheet, I was able to calculate mean and standard deviation of the 17 respondents to the survey. The spreadsheet was placed on the jump drive with all the other materials and locked in a file cabinet at the residence of the researcher.

Student Journals

The student journals were archival records that the researcher obtained upon the approval from the Institutional Review Board (IRB) of Walden University, which was granted on June 30, 2014. These 17 student journals were Microsoft Word documents and numbered 1-17. Since the researcher was not going to do cross-analyze between students gender, age, or with any other data collection material in this case study, the researcher randomly labeled the surveys J1, J2, J3, etc. Next, the data was placed in Nvivo 10 to code for themes and patterns. The Nvivo software program is located on the researcher's password -protected computer at the researcher's residence. Subscription was purchased for 6 months and once the subscription to Nvivo 10 expires, it will no longer be accessible to the researcher. Document files from this program have been saved on a jump drive specifically for this case study and locked in a file cabinet for 5 years at the residence of the researcher.

Teacher Interview

A teacher interview was conduct on July 8, 2014 after the researcher obtained the approval from the Institutional Review Board (IRB) of Walden University. The interview was conducted in the engineering teacher's office at the high school. The interview was recorded and then transcribed using Microsoft's Word Document speech-to-text recognition program. After the interview was transcribed into a text format, I listened to the entire transcript four times and made sure the text matched the teacher's response. Finally, the transcript was uploaded to Nvivo 10 so the teacher's interview could be coded for themes.

Student Interviews

After the approval from the Institutional Review Board (IRB) of Walden University, a purposeful sampling was used to identify six students for interviewing. The purposeful sampling for this case study were of participants who were high, medium, and low performers during the implementation of the PM (1998) in the introductory engineering classroom. I used grades from the paper roller coaster project to select two students from each level for the student interviews. Since students were out on summer break when the IRB approval was granted, it was difficult getting students to participate. School began on August 6th, 2014 and I was able to get students to participate. Unfortunately, the timing for these interviews to take place in the front office conference rooms became a massive challenge because of the unavailability of the conference rooms. There were numerous parent conferences as well as various testing taking place throughout the month of August. Also, getting the students to return the required signed

forms was daunting and required many reminders. Finally, the first interview occurred on September 4, 2014 and the last interview was completed on September 12, 2014. These interviews were conducted in a conducive setting and all six participants were willing to share their experiences. Participants were not restricted on time which allowed them to share in depth experiences of the paper roller coaster project.

The student interview questions (see Appendix D) consisted of 11 open-ended questions. I encouraged the student participant interviewee to feel comfortable to express their thoughts about the phenomenon known as the PM. These interviews averaged around ten minutes and were recorded so that transcription could be done. Microsoft's Word Document speech-to-text recognition program was used to help the transcription. After the interview was transcribed into a text format, I listened to the entire transcript four times and made sure the text matched the student's responses. Once all the data was transcribed, I used Nvivo 10 software to perform the inductive coding process so that I could locate dominant themes. The recording of the student interviews are located on the jump drive designated for this case study and will be kept in a lock file cabinet at the researcher's residency for five years and then will be destroyed.

Data Analysis

For this case study, I implemented descriptive and content analysis as well as open coding. I used descriptive analysis for the student survey to find the percentage, mean (*M*), and standard deviation *(SD)* for the 12 survey items. For the student reflective journals, student interview, and teacher interview, I used content analysis with open coding to find categories and themes.

Analysis of Student Survey

Student surveys used descriptive analysis where I found the percentage, *M* and *SD* of each of the 12 survey items. Also, I used descriptive analysis to find the percentage, *M* and *SD* for the six survey items that addressed RQ1 for motivation to learn and the six survey items that addressed RQ2 for critical thinking when used with the PM (Shepherd, 1998). In the student survey, a 5-point Likert scale with 12 question survey (1 = *strongly agree* to 5 = *strongly disagree*) was collected from 17 participants. I randomly assigned each survey a letter of S plus a number (e.g., S1, S2, S3, etc.). Using an Excel spreadsheet, I was able to locate the *M* and *SD* from the data collection from the student survey (see Table 3).

Student survey analysis for RQ1. Survey items 2, 4, 5, 9, 11, and 12 addressed motivation to learn while using the PM and were analyzed for RQ1 which asked: *How does the PM impact high school students' motivation to learn when implemented in a CTE program?* Even though question 2 on the student survey addressed motivation, it did not directly mention the PM (Shepherd, 1998); however, it did refer to the major structural components of the PM which is based on project-based and problem-based learning. The second survey item asked: *I enjoyed learning in a project-based and problem-based learning environment*. The *M* for this question was 1.41 which represents on the 5-point Likert scale *strongly agree* with a *SD* of .51. This was the most positive response for the entire student survey. Ten students (59%) responded *strongly agree* and seven students (41%) responded *agree* to the structural components of the PM. Overall,

17 students (100%) indicated that project-based and problem-based learning positively motivated students to learn.

Table 3

Descriptive Analysis of Student Survey Item

Student Survey Item	M	SD
	(*N* =17)	
1. The Probe Method was helpful for me to think critically.	1.71	0.69
2. I enjoyed learning in a project-based and problem-based learning environment.	1.41	0.51
3. I understand more about thinking critically because of the skills I learned using the Probe Method.	1.94	0.83
4. I enjoyed working collaboratively with a partner and a group to research, design, and build a paper roller coaster.	1.76	0.83
5. I enjoyed building a paper roller coaster because the Probe Method made learning more exciting.	1.94	0.75
6. My experience gained from learning to think critically of how-to build a paper roller coaster provided me with more confidence.	2.29	0.92
7. The Probe Method did not make it more difficult to design a paper roller coaster.	3.06	1.14
8. In general, I think I am better able to think critically using the Probe Method.	3.65	1.22
9. I like working individually, I did enjoy working collaboratively with a partner and a group to research, design, and build a paper roller coaster.	2.53	1.07
10. I feel I did acquired adequate skills to think critically by using the Probe Method.	2.47	1.01
11. The Probe Method was helpful in motivating me to think critically.	1.82	0.81
12. I did enjoy building a paper roller coaster because the Probe Method did make learning more exciting.	1.47	0.62

Note. Items 7, 8, 9, 10, 11, and 12 were reversed scored prior to computing. These item were changed in the table to reflect this adjustment.

Item 4 on the student survey addressed motivation to learn. The fourth survey item asked: *I enjoyed working collaboratively with a partner and a group to research, design, and build a paper roller coaster*. Once again the item does not directly refer to the PM but it does refer to the processes that the students perform while using the PM. The *M* for the fourth survey item was 1.76 which represents on the 5-point Likert scale *agree* with a *SD* of .83. Students of *N*=17 population who felt the PM design structure encouraged learning was eight students (47%) who responded *strongly agree* compared to five students (29%) who responded *agree*, and four students (24%) who responded *neutral*. Overall, 13 students (76%) positively responded that the PM encouraged students to work collaboratively compared to four students (24%) who responded neutrally.

Item 5 on the student survey addressed motivation to learn. The fifth survey item asked: *I enjoyed building a paper roller coaster because the PM made learning more exciting*. In item 5, the PM is directly referenced as well as motivation to learn. The *M* for the fifth survey item was 1.94 which represents on the 5-point Likert scale *agree* with a *SD* of .75. Students of *N*=17 population who felt the PM design structure encouraged learning was five students (29%) who responded *strongly agree* and eight students (47%) who responded *agree*, compared to four students (24%) who responded *neutral*, no student (0%) responded to *disagree*, and no student (0%) responded to *strongly disagree*. Overall, 13 students (76%) positively responded that the PM did impact their motivation to learn compared to four students (24%) who responded neutrally.

Items 9, 11, and 12 were reversed coded as (1=5, 2=4, 3=3, 4=2, and 5=1) prior to computing. Item 9 on the student survey addressed motivation to work with others. The ninth survey item asked: *I like working individually, I did not enjoy working collaboratively with a partner and a group to research, design, and build a paper roller coaster*. The *M* for the ninth survey item was 2.53 which represents on a 5-point Likert scale *neutral* with a *SD* of 1.07. Students of *N*=17 population who liked working with a partner and a group to research, design, and build a paper roller coaster instead of working individually were three students (18%) who responded *strongly agree*, five students (29%) who responded *agree*, seven students (41%) who responded *neutral*, one student (6%) responded *disagree*, and one student (6%) responded *strongly disagree*. Reverse scoring from the negative to the positive focus of the design structure of the PM in item 9 indicated that eight students (47%) positively responded that they liked working in a group, compared to seven students (41%) who responded neutrally, and two students (12%) negatively responded they did not like working in a group.

Item 11 on the student survey addressed motivation to work with others and asked: *The PM was not helpful in motivating me to think critically*. In item 11, the PM is directly referenced and addressed motivation to thinking critically. The *M* for the eleventh survey item was 1.82 which represents on the 5-point Likert scale agree with a *SD* of .81. Students of *N*=17 population who felt the PM motivated them to think critically was six students (35%) who responded *strongly agree*, nine students (53%) who responded *agree*, compared to one student (6%) who responded *neutral*, one student (6%) responded *disagree*, and no student (0%) responded *strongly disagree*. Reverse scoring

from the negative to the positive focus of the PM motivating critical thinking in item 11 indicated that fifteen students (88%) positively responded that the PM motivated students to think critically, compared to one student (6%) who responded neutrally, and one student (6%) negatively responded that the PM did not motivate them to think critically.

Item 12 on the student survey addressed motivation to work with others and asked: *I did not enjoy building a paper roller coaster because the PM did not make learning more exciting*. In item 12, the PM is directly referenced and addressed motivation to thinking critically. The *M* for the twelfth survey item was 1.47 which represents on the 5-point Likert scale *strongly agree* with a *SD* of .62. Students of *N*=17 population who responded that the PM made learning more exciting were ten students (59%) who responded *strongly agree*, six students (35%) who responded agree compared to one student (6%) who responded *neutral*, no student (0%) responded *disagree*, and no student (0%) responded *strongly disagree*. Reverse scoring from the negative to the positive focus of who enjoyed building the paper roller coaster because the PM made learning more exciting in item 12 indicated that sixteen students (94%) positively responded that the PM made learning more exciting, compared to one student (6%) negatively responded that the PM did not make learning more exciting.

Survey item 2, 4, 5, 9, 11, and 12 all addressed motivation to learn while using the PM and the *M* for these six survey question was 1.82 which represents on the 5-point Likert scale *agree* with a *SD* of .85. Having six item with a total of 17 participants resulted in 102 responses to the first RQ that addressed how the PM's impact on high

school students' motivation to learn when implemented in a CTE program. Overall, 82 (80%) of the 102 responses positively indicated that the PM impacts students' motivation to learn and 17 students (17%) responded neutrally, compared to three responses (3%) that negatively responded that the PM does not impact students' motivation to learn.

Student survey analysis for RQ2. Student survey item 1, 3, 6, 7, 8, and 10 addressed critical thinking while using the PM and were analyzed for RQ2. Question 1 on the student survey addressed critical thinking. The first survey question asked: *The PM was helpful for me to think critically*. In question 1, the PM is directly referenced as well as critical thinking. The *M* for the first student survey question was 1.71 which represents on the 5-point Likert scale *agree* with a *SD* of .69. Students of *N*=17 population who responded that the PM encouraged critical thinking were seven students (41%) who responded *strongly agree*, eight students (47%) who responded *agree*, compared to two students (12%) who responded *neutral*, no student (0%) responded *disagree*, and no student (0%) responded *strongly disagree*. Overall, 15 students (88%) positively responded that the PM did help them with thinking critically compared to two students (12%) who responded negatively that the PM did not help them with thinking critically.

Question 3 on the student survey addressed critical thinking skills. The third survey question asked: *I understand more about thinking critically because of the skills I learned using the PM*. In question 3, the PM is directly linked to the skills for thinking critically. The *M* for the third student survey question was 1.94 which represents on the 5-point Likert scale *agree* with a *SD* of .83. Students of *N*=17 population who responded

that the PM provided them skills to critical think were six students (35%) who responded *strongly agree*, six students (35%) responded *agree*, compared to five students (29%) who responded *neutral*, no student (0%) responded *disagree*, and no student (0%) responded *strongly disagree*. Overall, 12 students (71%) positively indicated that the PM did provide them with skills needed to think critically compared to five students (29%) who responded negatively that the PM did not provide them with skills needed to think critically.

Question 6 on the student survey addressed learning to think critically during the paper roller coaster project which implement the PM. The sixth survey question asked: *My experience gained from learning to think critically of how-to build a paper roller coaster provided me with more confidence.* In question 6, the PM is not directly mention, but was the instructional design used to build the paper roller coaster project. The *M* for the third student survey question was 2.29 which represents on the 5-point Likert scale agree with a *SD* of .92. Students of $N=17$ population who responded that they gained more confidence in learning to think critically while designing the paper roller coaster which implement the PM were four students (24%) who responded *strongly agree*, five students (29%) , compared to seven students (41%) who responded *neutral*, one student (6%) responded *disagree*, and no student (0%) responded *strongly disagree*. Overall, nine students (53%) positively indicated that they gained confidence with their critical thinking skills while designing the paper roller coaster, compared to seven students (41%) who responded neutrally, and one student (6%) who responded negatively that

they did not gain confidence with their critical thinking skills while designing the paper roller coaster

Student survey item 7, 8, and 10 were reversed coded as (1=5, 2=4, 3=3, 4=2, and 5=1) prior to computing. Reversed scored question 7 on the student survey addressed how the PM made designing the paper roller coaster easier. The seventh student survey question asked: *The PM made it more difficult to design a paper roller coaster*. The *M* for the seventh student survey question was 3.06 which represents on a 5-point Likert scale *disagree* with a *SD* of 1.14. Students of *N*=17 population two students (12%) who responded *strongly agree*, two students (12%) who responded *agree*, compared to eight (47%) who responded *neutral*, three students (18%) who responded *disagree*, and two student (12%) who responded *strongly disagree*. Reverse scoring from the negative to the positive focus of how the PM made designing the paper roller coaster easier in question 7 indicated that ten students four students (24%) positively responded that their critical thinking skills improved when used with the PM, compared to eight students (47%) who responded neutrally, and five students (29%) who responded negatively because they did not think the PM made designing the paper roller coaster easier.

Reversed scored question 8 on the student survey addressed improved thinking critically by using the PM. The eighth student survey question asked: *In general, I think I am better able to think critically than before using the PM.* The *M* for the eight student survey question was 3.65 which represents on a 5-point Likert scale *disagree* with a *SD* of 1.22. Students of *N*=17 population who responded that their critical thinking skills increased when they implemented the PM was five students (29%) who responded

strongly agree, five students (29%) who responded *agree*, compared to four (24%) who responded *neutral*, two students (12%) who responded *disagree*, and one student (6%) who responded *strongly disagree*. Reverse scoring from the negative to the positive focus of the PM improving critical thinking skills in question 8 indicated that ten students (59%) positively responded that their critical thinking skills improved when used with the PM, compared to four students (24%) who responded neutrally, and three students (18%) who responded negatively because they did not think the PM improved their critical thinking skills.

Question 10 was reversed scored and addressed how the student acquired adequate skills to think critically by using the PM. The tenth student survey question asked: *I feel I did not acquired adequate skills to think critically by using the PM*. The *M* for the student survey question eight was 2.47 which represents on a 5-point Likert scale *agree* with a *SD* of 1.01. Students of *N*=17 population who responded that they acquired adequate skills to think critically by using the PM were three students (18%) who responded *strongly agree*, six students (35%) who responded *agree*, compared to five students (29%) who responded *neutral*, three students (18%) who responded *disagree*, and no student (0%) responded *strongly disagree*. Reverse scoring from the negative to the positive focus of the PM improving critical thinking skills in question 10 indicated that nine students (53%) responded positively that they improved their critical thinking skills when used with the PM, compared to five students (29%) who responded neutrally, and three students (18%) responded negatively that they did not think the PM improved their critical thinking skills.

Survey items 1, 3, 6, 7, 8, and 10 all addressed critical thinking while using the PM and the *M* for these six survey question was 2.52 which represents on the 5-point Likert scale *agree* with a *SD* of 1.17. Having six item with a total of 17 student participants resulted in 102 responses to the second RQ that addressed: *How does the PM impact high school students' critical thinking skills when implemented in a CTE program?* Overall, 52 (51%) of the 102 responses positively indicated that the PM impacts students' critical thinking and 31 students (30%) responded neutrally, compared to 19 responses (19%) that negatively responded that the PM does not impact students' critical thinking.

Analysis of Student Reflection Journals

Students were provided nine reflective questions at the mid-point and end of the paper roller coaster project that they answered in their digital engineering journals. Students' reflective journal questions 2, 3, and 4 addressed RQ1 asked: *How does the PM impact high school students' motivation to learn when implemented in a CTE program?*

Students' reflective journal questions 1, 5, 6, 7, and 9 addressed RQ2 which asked: *How does the PM impact high school students' critical thinking skills when implemented in a CTE program?* Students' reflective journal question 8 does not specifically address RQs 1 and 2; therefore, was not analyzed. These student reflective journals where coded in Nvivo 10 and themes emerged from the open coding and content analysis of the analyzed data. Finding the dominant theme began with using three or more of the same responses for each of the student mid-point and end of project journal questions. All participants were given pseudonyms (see Table 2).

Students' mid-point reflective journals results to RQ1. Question 2 on the student reflective journal question addressed excitement while using the PM and asked: *What part of the PM do you enjoy working on?* There were four dominant themes that emerged from the coding of question 2. These four themes were (1) hands-on, (2) collaboration, (3) creativity, and (4) sharing ideas. Eight students wrote about how they liked the hands-on aspect of the PM. Max stated, "I enjoyed actually building the roller coaster and creating the individual parts and seeing when the marble successfully passed a point of difficulty", as well as, Ashley who noted that she liked "The hands on approach the most." Three students wrote they enjoyed the collaboration aspect of the PM. Jack stated that "Working with a group so every member could provide their take on what the coaster should look like" motivated Jack to learn because he was able to work collaboratively with his teammates to design the paper roller coaster. Another three students wrote about how they were able to experience creativity with the PM. Taylor shared that she "Enjoy[ed] the creativity side of it, [and] being able to use …[her] imagination was fascinating." Lastly, three more students wrote they enjoyed sharing their idea. Cooper replied, "I enjoy problem solving while working on the project. I liked watching how the groups solutions worked out." The PM encouraged learning by providing active learning, collaboration, sharing of ideas, and more importantly allowed students to think creatively.

Question 3 on the student reflective journal question addressed lack of excitement while using the PM and asked: *What part of the PM do you NOT enjoy working on?* There were three dominant themes that emerged from the coding of question 3. These

three themes were (1) research, (2) collaboration, and (3) design. Five students wrote about how they did not like the researching aspect of the PM. Four students indicated they did not like collaboration and four students wrote they did not like having to design the paper roller coaster while using the PM. Cooper indicated that "Researching was not one of the best parts to work on because it was a tedious task" along with Max who stated that "I did not really enjoy researching or answering the questions." Both of these students were not in favor of researching. Compared to Leo, who expressed frustration working collaboratively with his team by pointing out "I did not like the participation from my group. Some did not help with certain things." Jared was not in favor of building because he stated that "Hands on is also one of the hardest concepts to implore because of its large room for error." While many students were in favor of designing the paper roller coaster, three other students shared Jared's opposition to the design component of the project.

Question 4 on the student reflective journal question asked: *How does the PM make learning more exciting than a lectured based lesson?* There were two dominant themes that emerged from the coding of question 4. These two themes were (1) hands-on and (2) collaboration. Fourteen students wrote about how the PM allowed for hands-on activity which made learning more exciting. Jack explained that "It's hands on! Multiple people have a say rather than just one teacher." Heather reported, "The PM allows us to be hands on!" Cooper agreed with Heather that "The PM displayed more hands on lessons then just sitting there and receiving the instructions." Jared summarized by stating, "Students are more involved in the project" which made the PM much more

exciting than a lectured based lesson. Four students wrote they thought the PM encouraged collaboration. Austin reported that “The PM allows us to work together” and this made learning exciting.

Students’ mid-point reflective journals results to RQ2. Question 1 on the student reflective journal question addressed: *What problems, if any, did you encounter with researching topics for solutions to the design problem of the paper roller coaster?* Even though the PM is not specifically mentioned, research is a major component of the PM. There were two dominant themes that emerged from the coding of question 1. These dominant themes were (1) no problem with researching and (2) problem with researching. These responses indicate that eight students did not have any problems with researching, six students indicated they did have a problem or concern with researching, and four students were off topic and their response to the question and was not coded. Andy confirmed that he “Did not encounter any problems with researching topics on the paper roller coaster and the design problem” along with Heather who wrote, “I did not encounter any problems researching topics.” In contrast, Jill mentioned that “One problem I had with researching topics for solutions was making sure each solution was accurate in solving problems.” Tiffany worried that “There were not going to be enough articles on this particular project.” Another problem with researching was that many Internet sited were blocked by the firewall installed by the school district. Leo confirmed this by stating, “When researching, some of the websites for actual roller coasters I wanted to use were blocked.” Consequently, student would could not use these web sites and had to seek additional information from other web sites.

Question 5 on the student reflective journal question addressed: *How do you like working collaboratively with a partner while researching? Explain in detail any issues negative or positive do you experience when working with a partner while researching.* There were two dominant themes that emerged from the coding of question 5. These dominant themes were (1) no problem researching with a partner and (2) different Opinions. Five students did not have any problems with researching with a partner where five students wrote that different opinions were an issue while building the paper roller coaster using the PM. According to Heather, "It worked out great; each person was given a job and completed their task allowing us to finish parts faster." Jack concurred with Heather by stating, "there were no major problems researching with a partner." However, Taylor pointed out that "I expanded our research options; the negative side was we had different ideas so our minds clashed." This was also echoed by Belle who revealed, "It can be easy, but there are some issues, different opinions and ways of working can be a problem, such as a dislike of certain things." Overall, working collaboratively was a positive aspect of the PM, but there were situations that presented a challenge.

Question 6 on the student reflective journal question addressed: *How do you like working collaboratively with a group?* Explain in detail any issues negative or positive do you experience when working with a group while determining the best research for solving the problem for designing and building the paper roller coaster. There were three dominant themes that emerged from the coding of question 6. These dominant themes were (1) knowledge sharing, (2) fun working with a group, and (3) difficult working with

a group. Four students wrote they liked working in a group because they could share their knowledge with each other. Donna responded by stating,

> There was no research disagreement. I love working with the group because it gets a lot more done in less time. It pools abilities so we all do what we're best at, and its good company for fun. Our #1 disagreement was minor and quickly resolved.

Max concurred with Donna by reporting that he liked "How we had different views on how to overcome any problems we faced in building the roller coaster." Four students wrote that they had fun working collaboratively whereas four students wrote they did not enjoy working collaboratively in a group. Heather was one of the students who had fun working collaboratively. She noted that she liked "How we had different views on how to overcome any problems we faced in building the roller coaster." Whereas Maggie reported that she "Only experienced negative effects of working in a group." She further explained that " I found myself doing most of the work and keeping my members on track." Mostly, students agreed that working with a group was beneficial.

Question 7 on the student reflective journal question addressed: *What challenges are you faced with in designing, building, and testing the paper roller coaster?* Explain if you experience any moments of frustration, success, doubt, failure, or success during these challenges. There were three dominant themes that emerged from the coding of question 7. These dominant themes were (1) designing the paper roller coaster correctly (2) time, and (3) frustration. Eight students wrote they had challenges with designing and building their paper roller coaster. Jodi stated, "We faced challenges with building the

roller coaster." This statement summarizes how all eight students felt about designing and then building their prototype paper roller coaster. Max shared his concern by stating that "I was a bit afraid when the other groups were ahead of us and we are still trying to build." Whereas Jack's concern was "Getting the coaster to successfully run the track without messing up." Additionally, five students wrote that they were concern with completing their paper roller coaster by the due date. Donna expressed how time was her enemy. She stated, "Obviously time. We have cool ideas, but implementing them is going to be difficult with the time we have." This same sentiment was felt by Tiffany who reported that "deadlines were the main thing because it makes it so we had to rush at times." Students were provided a deadline and learning to complete components of the PM by certain deadlines was a challenge to many of these high school students. Consequently, five students wrote they were experiencing frustration with designing, constructing, and meeting the deadlines for the paper roller coaster project. Belle shared how she felt while building the paper roller coaster by stating, "I felt frustrated and doubtful at times, but when we found a solution it was awesome." John shared that "the group is getting frustrated while building the roller coaster and making it work is the problem." Andy echoed the same concern by stating, "I experienced frustration because the marble would stop at the bottom of the loops, trying to make it go backwards, and getting through the turns." It was apparent by students reflective journal responses that student were experiencing frustration during various stages of the PM.

Question 9 on the student reflective journal question addressed: *What critical thinking skills have you used so far in designing, building, and testing the paper roller*

coaster? There were four dominant themes that emerged from the coding of question 9. These dominant themes were (1) brainstorming, (2) evaluation, (3) problem solving, and (4) analysis. Seven students wrote they used brainstorming while building the paper roller coaster. Jodi indicated that "brainstorming together and figuring out how everything is going to be set up" were the critical thinking skills she implemented while designing, building, and testing her roller coaster. Mirroring Jodi's response, Taylor stated that her "imagination led the way" which helped her with construction of her paper roller coaster. Six students wrote that they had to modify, predict, and research which are all components of evaluation which is a critical thinking skills. Cooper reported that "modifying" was a critical thinking skill that he had to use because he stated, "We had to constantly change the design in order for our marble to successfully come in compliance with the roller coaster." Four students wrote they implemented problem solving which included planning. Ashley explained that "We brainstormed ideas for a prototype and used problem solving skills to solve design flaws." Additionally, Jared revealed he used "Critical thinking skills, but planning [was] the most difficult due to time constraints." There were three students who wrote they used analysis when creating their paper roller coaster project. Heather indicated that her team used critical thinking skills by stating that "We analyzed our projects constraints and specifications" and Leo concurred with Heather that he team was "Analyzing [their] projects constraints and specifications to meet the teacher's standards." The PM encouraged students to activate various critical thinking skills throughout the paper roller coaster project. The students reported that they

implemented brainstorming, evaluation, and analysis throughout the different stages of the project.

Students' end of the project reflective journal results to RQ1. Question 2 on the student reflective journal question addressed excitement while using the PM and asked: *What part of the PM do you enjoy working on throughout the project?* There were three dominant themes that emerged from the coding of question 2. These three themes were (1) building, (2) problem solving, and (3) communication. Thirteen students wrote about how they liked the building aspect of the PM. Austin confirmed this by stating, "The hands on project part was enjoyable because we actually saw our ideas came to life with the rollercoaster." This was reiterated by Jodi who wrote, "I enjoyed actually doing the hands on part building the rollercoaster." Also, four students wrote they enjoyed problem solving as they were having to test their paper roller coaster design. Belle was straightforward when she reported that "Problem solving, [and] trying to fix errors" were challenging and fun while constructing the paper roller coaster. There were three students who wrote they enjoyed sharing their ideas and communicating those ideas to their group members. Austin acknowledged that "The hands on project part was enjoyable because we actually saw our ideas came to life with the rollercoaster." Tiffany reinforced what Austin acknowledged because she stated that it was important to figure "out our design and how we wanted to build it. We combined all of our ideas, really, and put our personalities in our roller coaster and I thought that was nice." Working collaboratively to problem solve was an important component from the PM that students were able to utilize while building their paper roller coaster.

Question 3 on the student reflective journal question addressed non-excitement while using the PM and asked: *What part of the PM do you NOT enjoy working on throughout the project?* There were two dominant themes that emerged from the coding of question 3. These two themes were (1) did not like researching and (2) liked all parts of the PM. Six students wrote about how they did not like the researching aspect of the PM. Jill was on of the six students who did not like researching. She stated, "The research, it was boring, and difficult to write up in understandable words." Taylor also confirmed that she did not like researching by indicating that "research, it was boring and tedious." Whereas Jodi shared that she did not like researching when she reported, "I didn't like to research, but it did help when it came to design and ideas for the rollercoaster." Jodi did understand the benefit of researching even though she did not like researching. There were three students who responded that they like all the components of the PM. Donna acknowledged that she "actually enjoyed all of it' along with Cooper who responded by stating, "Overall, I enjoyed it." These students liked the researching component of the PM compared to some who did not enjoy researching.

Question 4 on the student reflective journal question asked: *How did the PM make learning more exciting than a lectured based lesson?* There were three dominant themes that emerged from the coding of question 4. These three themes were (1) hands-on, (2) more exciting, and (3) collaboration. Eleven students wrote about how the PM allowed for hands-on activity which made learning more exciting. Tiffany explained that

> I personally learn better by doing things myself, and I end up finding new ways of how to do something. I'm very creative so I think my mind came in handy for this

> project and it was definitely an experience. I worked some wonders, I can say. But my mind does tend to shut down when I'm lectured, at least on something that doesn't appeal to me or my tastes. So I'd say working with hands-on projects is way better.

Interestingly, Tiffany summarized what many of the students indicated that active learning was more appealing than a lectured lesson. Jodi concurred with Tiffany when she reported that "Lectures are boring to me I rather have the hands on part of the project because it is easier to learn from your mistakes." Additionally, three students wrote that that PM made learning more exciting. Jared pointed out that "It [the PM] helps people bond together and having to think hard. Overall it's a fun experience." Also, Austin agreed that the PM made learning more exciting when he stated, "We as a class got to work with other people as a group which made thing more exciting than a lectured based lesson." There were three students who indicated they thought the PM encouraged collaboration and this made learning exciting. Heather expressed how doing this project with the PM was much better than a lecture. Heather noted, "So much more fun having hands on building a whole roller coaster and meeting more people rather than sitting here and listening to you lecturing us and giving us an actual exam test, so thank you for that." The teacher used this project as a performance based assessment instead of a paper and pencil exam which added to the significance of the project.

Students' ending reflective journals results to RQ2. Question 1 on the student end of the project reflective journal question addressed: *What problems, if any, did you encounter with researching topics for solutions to the design problem of the paper roller*

coaster? Since question 1 does not specifically mention the PM, it does address research which is a major component of the PM. There were two dominant themes that emerged from the coding of question 1. These dominant themes were (1) problem with researching and (2) no problem with researching. These responses indicated that eight students did have problems with researching while five students indicated they did not have a problem or concern with researching. Several students indicated they had issues with researching and it appears that they had different issues of concern with their search for specific information. Jodi explained,

> There were many struggle that came too researching the different designs but one of the biggest was finding a rollercoaster whose car resembles a marble. We ended up using a rollercoaster from six flags in Ohio whose ride is similar to what we wanted to achieve.

Heather also reported that "While researching it was hard to get all the answers because when I looked them up the answers never spawned." Compared to Andy who indicated that "The only difficulties were mixing the information with the knowledge we already had." On the other hand, Donna shared that her team "didn't really have any problems" along with Cooper who wrote, "We didn't really have any problems with the research." Researching for this project appeared to be an issue with various students while several students enjoyed this component of the PM and did not experience any difficulties.

Question 5 on the student end of the project reflective journal question addressed: *How do you like working collaboratively with a partner while researching?* Explain in detail any issues negative or positive do you experience when working with a partner

while researching. There were four dominant themes that emerged from the coding of question 5. These dominant themes were (1) enjoyed working with a partner, (2) divided the work, (3) collaboration, and (4) no problem researching. Four students enjoyed researching with a partner. Jared explained, “It’s great to have a partner when doing something like this, great minds think alike so without help I couldn’t do it” and Donna noted that “I enjoyed working with a partner it was less work on each individual person and the work was divided equally.” There were three students who indicated they liked how the work was less because they were able to divide the work among each other. Heather confirmed this by stating, “It [having partners] really helped, so one person gets half of the questions while the other gets the other questions finished. Most of this was pretty easy.” Sharing of tasks and working together was much more beneficial than working individually. There were three students who wrote they liked working collaboratively with a partner. Maggie claimed, “It was more efficient. Though it created many altercations over design” and Jack reported that “We both had answers to different questions so we figured it out together and faster than alone. There were three students that indicated they did not have a problem researching with a partner. Ashley responded that “Researching went smoothly data was recorded ok” along with Cooper who stated that “We didn’t have any problems with the researching.” Learning to work collaboratively with other people is a valuable skill that is essential in the workforce and the students in this class where provided this experience while building a paper roller coaster using the PM.

Question 6 on the student end of the project reflective journal question addressed: *How do you like working collaboratively with a group?* Explain in detail any issues negative or positive do you experience when working with a group while determining the best research for solving the problem for designing and building the paper roller coaster. There were two dominant themes that emerged from the coding of question 6. These dominant themes were (1) fun working with a group and (2) moments of disagreement. Eight students wrote they had fun working with a group. Five students wrote that they had moments of disagreement while working with a group. Jack pointed out that "It was very easy working with such a big team." While Leo explained, "I like working with people as long as everyone does their part." Tiffany stated that "Fortunately, I got to work with three people I know, and are friends with, so that made me feel less anxious and more excited." She did point out that "I did get to know everyone better though throughout the project, and we all have a good idea how each of us are, considering our minds were very involved in this." However, Tiffany did acknowledge that "since we're all very different from each other, some ideas weren't so understood or agreed with." Working in a group is difficult and Taylor confirmed this by stating, "We had our moments, we had ups and down, and arguments. But now we have a completed project." Sharing Taylor's concern about collaborating with a group, Jodi reported that "It was okay, we had problems when it came to the logical part of thinking how to actually build the rollercoaster because we really couldn't agree on a good way to build." Working with collaboratively with a group of people presents a challenge and

learning how to effectively and efficiently resolve issues is an important skill sought in the workforce.

Question 7 on the student end of the project reflective journal question addressed: *What challenges are you faced with in designing, building, and testing the paper roller coaster?* Explain if you experience any moments of frustration, success, doubt, failure, or success during these challenges. There were two dominant themes that emerged from the coding of question 7. These dominant themes were (1) time constraints and (2) frustration. Five students wrote that they were concern with completing their paper roller coaster by the due date or meeting the time criteria of the paper roller coaster project. Three students wrote they experiencing frustration with designing, constructing, and meeting the deadlines for the paper roller coaster project.

Tiffany covered both dominant themes completely. First she addressed the issue of time by reporting that “We really didn’t have much time and our first drawing of the roller coaster’s appearance wasn’t so realistic, either that or there wasn’t time to make it work.” Next, Tiffany addressed the issue of being frustrated when she explained that “we were all very overwhelmed at first and throughout it all, but we were okay.” Then, Tiffany addressed the issue of time and frustration when she explained, “I, myself, am very anxious about time, so I usually get things done as quickly as I can. We fortunately made it all happen, and it worked out. But of course, it took a lot of frustration and arguing.”

Austin felt the pressure of the time criteria placed on the travel time of the marble rolling down the roller coaster. The criteria for this project was 25 seconds or greater that

the marble had stay on the roller coaster. Austin believed, “The roller coasters time was a big stress because it was hard not to break the rollercoaster in the process of modifying the coaster but, eventually it worked out.” This sentiment was also expressed by Taylor who noted that “meeting the time requirement of 25 seconds” was the challenge her team faced and Belle stated that “There were many moments of frustration and failure. Coming up with new design ideas through trial and error. But once you finally make it work it is worth it.” Even though the students experienced many challenges, they also experienced moments of success.

Question 9 on the student end of the project reflective journal question addressed: *What critical thinking skills did you use in designing, building, and testing the paper roller coaster?* There were two dominant themes that emerged from the coding of question 9. These dominant themes were (1) problem solving and (2) brainstorming. Eight students wrote they used problem solving skills while building the paper roller coaster whereas five students wrote that they had implemented brainstorming throughout the project. Belle reported that

> Designing the roller coaster made everyone come together and submit their ideas. Building the roller coaster was mostly trial and error, we realized half of our ideas were not going to work, so we did have to rely on our research.

By implementing problem solving techniques, Belle acknowledged that her team had to refer back to their research to help finding a solution to their problems. Andy felt that critical thinking was present the most “when formatting the final design of the coaster.” It is during this stage that Andy believed his team relied on their critical thinking skills the

most. Jill indicated that her team difficulty with the design of the paper roller coaster, therefore, Jill described how her team worked together to find a solution. She noted, “We had to find out what would cause the marble to either shoot off or halt on the roller coaster. We also needed to make ample speed to make the first loop. We figured this out by trial and error.” Ashley’s team relied on brainstorming as critical thinking skill to find solutions during building and testing the paper roller coaster prototype. Ashley believed that “brainstorming ideas … would make the coaster “pop” from the rest” and would allow her team’s design to be different from other teams’ designs.

Analysis of Student Interview

The student interviews addressed two of the four RQs for this case study. The two RQs that the student interview addressed were RQs 1 and 2. I conducted a separate face-to-face interview with each of the six student and the students’ responses were recorded and then transcribed for content analysis and open coding for dominant themes. Finding the dominant theme began with using two or more of the similar responses to the question. Additionally, I gave pseudonyms for the six participants by randomly numbering their names. Once I had them randomly numbered, I gave the pseudonym that was assigned to the student participant number of this case study (see Table 2).

Student interview addresses RQ1. The first RQ addressed: *How does the teacher perceive the PM as a means to motivate students to learn in a high school CTE program?* The student interview was one of the three data sources used to answer this research question.

Student IQ1 asked*: Did the PM help motivate you to learn? Why or Why not?* The students responded positively that the PM did motivate them to learn. There was one dominant theme that emerged from the coding of question 1. This dominant theme was that the PM motivated learning. Five students stated that the PM motivated them to learn while building the paper roller coaster. Jill indicated that PM motivated her learning by stating,

> It did because it [the PM] was more of a hands-on thing then having to sit during a lecture and actually being able to do the process step by step on your own then sit and listen and probably not understand it.

The project-based and problem-based strategy structure and the collaboration aspect of the PM were components of the PM that she felt assisted with her motivation to learn. Donna stated, “I feel like it did, because getting to learn how to do things correctly like step-by-step and getting to work with other people.” Andy concurred with Donna because he believed, “it [the PM] did help me cause we did things in ways that you wouldn’t do in a textbook.” Andy, Donna, and Jill reported that the PM did motivate their learning. However, Leo indicated that the PM did not motivate his learning. Leo responded by stating, “It’s not how I usually learn.” He continued to explain why he though the PM did not motivate his learning by stating, “I usually don’t make, like, it’s kind of hard with big group because everyone is having all these different kinds of ideas, but if you work on your own you can decide on one idea by yourself.” Leo indicated that “it is a lot easier” working individually. Since the PM encourages collaboration, Leo appeared not to be

motivated by the PM because of the collaboration component of the learning model design.

Question 2 for the student IQ addressed the part of the PM motivation and asked: *What part of the PM, if any, motivated you the most?* There were two dominant themes that emerged from the coding of question 2. These two themes were (1) hands-on and (2) collaboration. Two students replied that they were motivated to learn because of the hands-on aspect of the PM. Two students reported they enjoyed the collaboration aspect of the PM. Donna was motivated the most by the hands on component. She noted, "I think it would be probably the hands-on part because it was fun and you got to, you got to learn from your own mistakes" Jack agreed with Donna that building the paper roller coaster was the part of the PM that motivated him the most. Jack acknowledged that "It [the PM] motivated me to learn to be able to create a roller coaster with different materials and do research with other people." Compared to Jill who felt that collaboration was the most important of the PM that motivated her to learn. Jill stated, "I would have to say team work." Working collaboratively and being engaged in the design, construction, and testing of the paper roller coaster were components that the PM fostered throughout the learning process of this project.

Student IQ3 asked: *What part of the PM, if any, motivated you the least?* There were two dominant themes that emerged from the coding of question 3. These two themes were (1) research and (2) collaboration. Three students indicated they did not like the researching aspect of the PM. Two students indicated they did not like the collaboration part of the PM. Donna admitted that researching motivated her the least.

She reported that “It would probably be the research because it was kind of boring sitting down and having to research.” Where Jill and Leo did not favor collaboration. Jill stated,

> Well, I think it might be collaboration again because if you have that problem that you can’t get along with them because they want to use one example over the other then you would have to figure out how to work both into.

Leo echoed that “I guess working with partners.” Leo favor more individual work instead of collaboration. Interestingly, collaboration was viewed as a motivator and a de-motivator component of the PM.

Student IQ4 asked: *How did the integration of technology during the implementation of the PM motivate you to learn?* There was one dominant theme that emerged from the coding of question 4. This one theme was technology motivated learning. Five students indicated that technology played an important part in motivating them to learn while using the PM during the paper roller coaster project. Leo explained, “I used it [technology]. It helps you understand a lot easier than from a lecture or PowerPoint or anything because you can search up exactly what you need to know” along with Donna who believed that “It [technology] helped a lot actually being able to visualize other people doing it and seeing how to put things together rather than jumping straight into it.” Belle stressed that “using technology helped it out more and I really like to use research with technology instead of just having a lecture, but I guess, it motivated a little bit more.” Technology was used in a variety of ways and stages throughout the paper roller coaster.

Student IQ10 asked: *What would you suggest to your teacher or other teachers on increasing student's motivation to learn by using the PM?* There was not a dominant theme that emerged from the coding of question 10. Students provided interesting suggestions on how to motivate learning when using the PM. Donna suggested, "Having a lot of hands-on projects" whereas student Jill focused on collaboration and the importance of allowing students the opportunity for getting to know each other: "They need to learn how to get to like know one another so they can actually be comfortable working on a team with somebody." Additionally, Leo indicated that "Playing videos that include using the PM in the video so you can easily get an understanding of what you are trying to do." He also suggested that having a video of the PM process would help understanding about the PM compared to Belle's suggestion that more guidance from the teacher would be helpful by stating, "I would say they would motivate me just on helping to critically thinking about it. Like, if I am stuck on one part they would help on and creating the next part to do." All suggestions provided valuable information for the teacher to improve future lessons.

Students' interview results to RQ2. Research question 2 asked: *How does the PM impact high school students' critical thinking skills when implemented in a CTE program?* Student interview questions 5, 6, 7, 8, 9, and 11 addressed critical thinking while using the PM and were analyzed for RQ2.

Student IQ5 asked: *Did the PM help you to think critically? Why or Why not?* There was one dominant theme that emerged from the coding of question 5. This one theme was the PM helped with thinking critically. All six students indicated the PM did

help them to think critically while building the paper roller coaster. Jack was straight to the point when he reported the PM helped him think critically. He stated, “Yes because, like I said before you have to think outside the box to fix crazy problems.” Leo mirrored Jack’s response by stating, “Yes it did. It caused us to have to kind of mush all of our ideas together, but also put them together in a big puzzle.” Whereas Andy believed it provided a variety of opportunities in different roles that required critical thinking skills. Andy noted, “I would say it did because it [the PM] put you in positions you were not use to because it kind of goes through all the positions you could be in.” Belle felt that “It [the PM] helped me think critically to [use] with problem solving.” The PM provided the opportunities that required students to implement higher order thinking skills.

Student IQ6 asked: *What critical thinking skills did you implement the most during the PM?* There were two dominant themes that emerged from the coding of question 6. These two themes were (1) problem solving and (2) analysis. Two students indicated that they implemented problem solving the most during the PM. Jack emphasized that problem solving was “basically the integral part of how we actually made the roller coaster work without that it then it would have just fall apart.” There were two students who reported that they implemented analysis the most during the PM. Jill recommended that “it would probably be analyzing the situation because we have to analyze it step by step to understand what was actually going on.” Problem solving and analysis was toggled back and forth as essential critical thinking skills used throughout the entire paper roller coaster project.

Student IQ7 asked: *What critical thinking skills did you implement the least during the PM?* There were two dominant themes that emerged from the coding of question 7. These two themes were (1) comprehension and (2) evaluation. Three students indicated that the least implemented critical thinking skill during the PM was comprehension. Donna implied that "It would probably have to be the comprehension because having other people and then you, it was kind of hard [to] like their ideas and then your ideas it was hard to comprehend the big of everything." Two students reported that they implemented evaluation the least during the PM. Jill indicated that she did not activate evaluation because she stated that "I think that evaluation probably would have been our biggest faults in that situation because again the whole team work thing." Her team had difficulty working collaboratively which limited their opportunity to implement evaluation of their work more thoroughly.

Student IQ8 asked: *What kind of critical thinking strategies did you implement when designing and building the paper roller coaster?* Since this questions allowed for multiple critical thinking strategies, the six students provided several strategies. The dominant themes that emerge were four responses for analysis, three responses for problem solving, and two responses each for knowledge and brainstorming. Donna, Andy, Jill, and Belle all reported that they used analysis. Jack, Andy, and Jill revealed that they implemented problem solving skills. Compared to Belle who acknowledged that she "had to use my knowledge of thinking about the roller coaster." Whereas Donna indicated that "the brainstorming part was complicated because we each had our own idea and we wanted to put it in there" she continued to explain that "It was hard having to

get over each other's aggravation because when I had an idea or they had an idea it would clash into each other." Donna further explained, "that it would be ever a grand idea, so we had to brainstorm a new idea and think of a new way to doing it." Therefore, brainstorming was an integral part of Donna's team because they had to learn how-to compromise on ideas.

Student IQ9 asked: *What part of the PM, if any, presented a challenge for you to think critically?* There were two dominant themes that emerged from the coding of question 9. These two themes were (1) collaboration and (2) brainstorming. Two students reported that collaboration that kept them from thinking critically during the PM. Donna reported that "the working together part was really hard it put a challenge to everything" and Leo stated, "Definitely, cooperating with others" were collaboration challenges for them to think critically while using the PM. Jill provided more explanation of this challenge by stating that "the most challenging was probably forming the group because you need to actually and have people who you think you work well with, you know, focus on the job so we could actually get it done on time." There were two students who indicated that brainstorming presented a challenge that kept them from thinking critically during the PM. Jack and Andy both agreed that brainstorming was a challenge. Jack explained that "the point where there was the most challenge was basically where we were drawing the design." This phase of the project required students to work with partners and it was during this stage that brainstorming of ideas was critical to the success of their project.

Student IQ11 asked: *What would you suggest to your teacher or other teachers on increasing student's critical thinking skills by using the PM?* There was one dominant theme that emerged from the coding of question 11. This dominant theme was structure. Two students suggested that the teacher or other teachers provide more structure as well as keep the structure in place because they enjoy having the structure that is provided with the PM, but wanted to make sure that more was added. Andy explained that structure "would have maybe helped us think a little bit more and figure it out. But then, it would also kind of bring it down some to, since you don't have to think as much." Also, Andy did indicate that "it would have made it easier to understand." Andy's point is that the structure of the PM is complicated, but breaking it down would lose the purpose of the PM which is encouraging students' to implement critical thinking skills and motivating students to learn.

Analysis of Teacher Interview

The teacher interview addressed two of the four RQs for this case study. The two RQs that the teacher interview addressed were RQs 3 and 4. I conducted a face-to-face interview with the teacher, Ms. Gardner, and her responses were recorded and then transcribed for content analysis and open coding.

Teacher interview addresses RQ3. The third RQ addressed: *How does the teacher perceive the PM as a means to motivate students to learn in a high school CTE program?* The teacher's interview was the data source used to answer this research question.

Teacher IQ1 asked*: Did the PM help motivate students to learn? Why or Why not?* Ms. Gardner responded positively that the PM did motivate students to learn. She noted,

> I am going to say, yes. A lot of group work they did, a lot of problem solving, their own problem solving, me stepping back, and giving them their space with . . . problem solving, a lot of group work, it was just fun watching them do their own problem solving, critical thinking, researching, getting a lot of feedback from, from each other.

Ms. Gardner emphasized that students were busy working collaboratively with each other. According to Ms. Gardner there was "a lot of noise because they were talking a lot" and this was an indication to her that the students were motivated to learn because they were actively engaged in their learning. Additionally, Ms. Gardner referenced to student reflection which an important component of the PM. The PM allows students the opportunity to reflect on their work and progress. This was an aspect that Ms. Gardener felt assisted with the students motivation to learn. Ms. Gardner reported,

> This hands on project was a little bit different because of [the] PM because I utilized more of reflections. Where I really, unfortunately, didn't do a lot of that with my prior projects; self reflections, I reflected a lot with them. So, I am going to say yes.

I asked, "Were they [students] excited to learn?" Ms. Gardner responded, "I am going to yes, versus … them sitting there [and me] talking to them about a project or you know things like that. They'd rather do it, rather than listen to me, they're more engaged in the

project." The teacher believed that students who become active participants in their learning develop motivation to learn because they are engaged in their learning process.

Teacher IQ2 asked: *What part of the PM, if any, motivated students the most?* Ms. Gardner got question 2 and 3 confused with each other. After clarification of the questions the teacher provided responses to the questions. The part that motivated the students the most while using the PM was working collaboratively in groups. Ms. Gardner answered, "Working collaboratively, I think they liked working as a group, they listened to one another, sometimes they didn't want to listen to each other." The PM pulls heavily on collaborative learning while providing opportunities to work with in groups, with partners, as well as, individually throughout the project. This mixture of collaboration mimics the real world working environment.

Teacher IQ3 asked: *What part of the PM, if any, motivated students the least?* This is where Ms. Gardner stated, "I am going to say, research, [it] was the least fun thing they all wanted to do . . . but they understood they had to do the research to be able to complete the project." Gaining knowledge and understanding of the problem is vital to solving the problem. The PM embraces researching because students need to have this skill to work competitively in the workforce and higher education. The teacher further explained why students are not motivated to research by explaining,

> They don't want to take the time to read, they want to hurry up and jump into a project with every, they always want to do that. Because they don't wanna sit there and read and take everything in, they'd rather just do it, and figure out from one another during the collaboration and such.

Teacher IQ4 asked: *How did the integration of technology during the implementation of the PM motivate students to learn?* Ms. Gardner commented on how the students would use their computers to seek solutions or answers to problems they were encountering during design, construction, and completion of the paper roller coaster. Also, they would use videos provided as their learning tools for learning how-to construct the paper roller coaster and other scientific elements essential to correctly designing the roller coaster (e.g., Newton's law of motion). Ms. Gardner stressed the importance of technology had on their motivation to learn by explaining,

> Yeah, definitely! It [technology] would have to. I mean, … definitely. It assisted them in their learning and in the building of their projects. I had videos for them … on how-to-create like certain turns or funnels or whatever so they had to go back to the how-to-videos and I kept all that stuff accessible for them.

Teacher IQ10 asked: *What would you suggest to other teachers on increasing student's motivation to learn by using the PM?* Ms. Gardner responded by stating,

> Take the time to use the reflection part of it, to motivate the kids, to motivate yourself as well, … follow-up what the students … actually learned from that lesson, [because] there is time to do that in the PM.

Teacher interview addresses RQ4. The fourth RQ addressed: *How does the teacher perceive the PM as a means to engage student in critical thinking skills in a high school CTE program?* The teacher's interview was the data source to answer this research question. Even though Ms. Gardner IQ8 did mention critical thinking, it did not include the PM and was not used for analysis.

Teacher IQ5 asked: *Did the PM help students to think critically? Why or Why not?* Ms. Gardner noted, “I am gonna say a big yes on that. I think problem solving, but problem solving with other people working together with all of the people.” The teacher concurred that problem solving was the most visible critical thinking skill that was being utilized by the students to design and construct the paper roller coaster project. Ms. Gardner also observed how the students worked collaboratively and communicated with each other while other were not. The teacher did a mid-point of the lesson reflection journal and this provided the insight that some students were not working collaboratively and were not listening to others. Since this is a high school environment, students are hesitant to verbally tell the teacher, but they will write about it to the teacher. Also, some students wrote they did not like working with others because their team members were not listening to them. Ms. Gardner explained, “Some of them were very truthful and saying about how they didn’t communicate with other people … [and] not listening to them.” Communication and listening is a subpart of the PM which allows for in depth critical thinking to take place. Consequently, if students were not effectively communicating and listening, then they would be missing an essential component of the PM.

Teacher IQ6 asked: *What critical thinking skills did the students implement the most during the PM?* Ms. Gardner stated,

> I would have to say problem solving and communication with their problem solving. They analyzed the project and such they analyze the … situation of the

> roller-coaster like what's not working, what is working, what can we do best. They feed off of that from each other.

The teacher observed students problem solving, communicating, and analyzing throughout the project. Ms. Gardner further explained,

> That's my goal for my class is to … problem solve. A lot of kids want to sit there, like I said that one little guy wanted to do it by himself, they want to sit there and in high school they really do not want to think . . . this project … it makes them think and that's what motivated them and [I] think they understood that.

Teacher IQ7 asked: *What critical thinking skills did the students implement the least during the PM?* Ms. Gardner noted, "Synthesizing." I asked for more information by asking, "Making it their own? Once they solved the problem, they couldn't go beyond that." The teacher added, "Yeah, but that is where team work came in."

Teacher IQ9 asked: *What part of the PM, if any, presented a challenge for students to think critically?* Ms. Gardner noted, "Putting everything together that is a big challenge for these kids. They gotta all work together and to solve a problem and they all have different views and they all have listen to one another." The teacher concluded, "Sitting back and watching the kids. It was a good thing. The reflection of it all." As mentioned by the teacher, the students had difficulty synthesizing. Seeing the students working and experiencing various levels of disequilibrium was a good learning experience for the students.

Teacher IQ11 asked: *What would you suggest to other teachers on increasing student's critical thinking skills by using the PM?* Ms. Gardner stated, "Increase more of the communication … and collaborating. Giving them more opportunities for that.

Emerging Themes

There were several overarching themes that emerged from the four data sources used in this case study. Taking the dominant themes from each data source questions, I was able to find overarching themes that addressed each of the four research questions. Since this case study focused on the role and function of the PM with specific attention to motivation to learning and critical thinking, there were several key themes that emerged for each research question.

Themes for RQ one. Research question 1 focused on how the PM motivated students to learn. Hands on activities and collaborations among the students were the emerging themes that addressed RQ1. The students indicated that hands on activities and collaboration with their peers were the leading factors that motivated learning while using the PM as the instructional model for the roller coaster project. There were 33 references to hands on activity within the student mid-point and ending reflective journals as well as 14 references to collaboration. In the students' interview there were five references to motivation to learn. The student survey had a *M* of 1.82 and *SD* of .85 for the six questions that addressed motivation to learn and this indicates that the students strongly agreed that the PM as an instructional model did motivate learning.

Themes for RQ two. Research question 2 focused on how the PM engaged students to critical think. The emerging themes for RQ2 revealed that students

implemented brainstorming, problem solving, collaboration, and researching the most while using the PM in the roller coaster project. Taking references from the three data sources for this research question, the cumulative total of 28 references to problem solving, 25 references to brainstorming, 16 references to collaboration, and 16 references to researching indicated that critical thinking skills were an important part of this paper roller coaster project. There were 21 positive references to brainstorming within the student mid-point and ending reflective journals as well as 20 references to problem solving. In the students' interview, there were eight positive references to problem solving. The student survey had a *M* of 2.52 and *SD* of 1.17 for the six questions that addressed critical thinking and this indicates that the student agreed that the PM as an instructional model did assist students in engaging critical thinking skills.

Themes for RQ three. Research question 3 focused on how the teacher perceived the PM as a means to motivate students to learn. The overarching themes that emerged from the teacher interview for RQ3 were collaboration, motivation, and technology. Ms. Gardner referenced collaboration 10 times, motivation 7 times, and technology 5 times throughout the interview. The teacher stated that "they [the students] liked working as a group." Ms. Gardner also indicated that the PM provided opportunities for students to work with technology and collaboratively which engaged students in the learning process.

Themes for RQ four. Research question 4 focused on how the teacher perceived the PM as a means to engage critical thinking skills in high school students who participate in a CTE program. The overarching themes that emerged from the teacher

interview for RQ4 were communication and problem solving. Ms. Gardner referenced communication 12 times and problem solving 9 times throughout the interview. The teacher stated that “they [the students] had to solve the problems amongst each other, so that was part of communication skills.” Allowing students the opportunity to communicate encouraged them to problem solve which included brainstorming for a variety of solutions.

Evidence of Trustworthiness

As explained in chapter 3 of this case study, I would maintain trustworthiness to the study by triangulation and member checking. I triangulated the student and teacher interviews, and archival records of the student surveys and student reflection journals to provide credibility to the study. Additionally, I conducted member checking by providing my participants in this case study the opportunity to review transcriptions of all material that were pertinent to them. No adjustments were needed after the participants reviewed their interview transcripts.

The reliability (i.e., dependability) strategy that was used for this case study was an audit trail. I kept a research journal and memos that captured all the specific details of conducting this case study. This audit trail describes how the study was conducted so anyone who wanted to duplicate this study will be able to accurately do so because they would have specific details of how I conducted this study.

Results

This section of chapter 4 provides the results from the four data sources used in this case study and is organized by the four RQs and overarching themes. These RQs

sought to examine the role and function of the PM as an instructional model for addressing motivation to learn and critical thinking skills among high school students in a career and technology education (CTE) program.

Research Question 1 Results

The first RQ addressed: *How does the PM impact high school students' motivation to learn when implemented in a CTE program?* The first RQ used three data sources which were (1) student surveys, (2) student reflection journals, and (3) student interviews to answer this research question.

Hands on learning, which is a structural component of the PM, was the overarching theme that addressed RQ1. Students who participated in this case study expressed overwhelmingly that the hands on activates motivates their learning. Student participant Austin stated in his mid-point reflective journal that "the hands on part is the part I most enjoy." This statement was echoed throughout many of the student journals that they enjoyed the PM because it made learning fun and exciting. Jill from the student interview reported that the PM did motivate learning through hands on by stating that "It [the PM] did because it was more of a hands-on thing than having to sit during a lecture."

Collaboration was the other overarching theme students referenced often for RQ1 because the students felt the PM did motivate them to learn. The structural design of the PM employs collaboration throughout its multiple step instructional model. Donna, noted in her ending reflective journal that "I enjoyed working with a partner." Austin concluded in his ending reflective journal that "We, as a class, got to work with other people as a

group which made things more exciting than a lectured based lesson." This statement reiterates that students enjoyed learning in an active learning environment.

Jared summarized the overall feeling expressed by many of the 17 students who participated in the paper roller coaster activity that "Overall it's a fun experience." Belle from her student interview reported that the PM did motivate learning through collaboration by stating that "It motivated me to learn to be able to create a roller coaster with different materials and do research with other people." This supports the data collected from the six student survey items that addressed if the PM motivated students to learn with a M =1.82 and a SD=.85. Data analysis from the three data sources answered RQ1 that the PM does impact high school students' motivation to learn when implemented in a CTE program.

Research Question 2 Results

The second RQ addressed: *How does the PM impact high school students' critical thinking skills when implemented in a CTE program?* The second RQ used three data sources which were (a) student surveys, (b) student reflection journals, and (c) student interviews to answer this research question.

Problem solving, brainstorming, collaboration, and researching was the overarching theme that aided in addressing RQ two. Students who participated in this case study expressed overwhelmingly that problem solving and brainstorming were the critical thinking skills they implemented the most doing the paper roller coaster activity. In Leo's student interview, he summarized most accurately that "brainstorming, collaboration with group, using our research material to solve our problems" were the

most dominant factors that assisted them with thinking critically. In Belle's student interview, she explained that

> "Designing the roller coaster made everyone come together and submit their ideas. Building the roller coaster was mostly trial and error; we realized half of our ideas were not going to work, so we did have to rely on our research."

Heather's student mid-point reflection journals reported that "we analyzed our projects constraints and specifications" and Jill's mid-point reflection journals stated that "Critical thinking skills I used in the process of our roller coaster were brain storming and using our creativity to predict whether or not our roller coaster is going to work or not." These statements provide evidence that students were implementing a variety of critical thinking skills throughout the multiple steps of the PM (Shepherd, 1998) which was the instructional model used with the paper roller coaster project. The descriptive analysis of six survey items which had a M=2.52 and a SD=1.17 indicated that the students agreed that the PM did encourage critical thinking while they built the paper roller coaster. The data analysis from the three data sources answered RQ2 that the PM does impact high school students' critical thinking skills when implemented in a CTE program.

Research Question 3 Results

The third RQ addressed: *How does the teacher perceive the PM as a means to motivate students to learn in a high school CTE program?* The third RQ used the teacher's interview to answer this research question. Using the overarching themes of collaboration, motivation, and technology, RQ3 addressed how the teacher perceived the PM as a means to motivate learning. Ms. Gardner indicated that students were motivated

to learn because of the opportunity the PM provided for students to work collaboratively. The teacher also noted that “they were more engaged in the project” and that “a lot of motivating went on” because they were active participants in their learning process instead of just listening to a lecture.” Additionally Ms. Gardner felt that technology did aid in student learning by stating, “It assisted them in their learning and in the building of their projects.” The teacher did perceive the PM as a means to motivate learning in high school students who participate in a CTE program because it allowed students to use technology and collaboration which were major components that engaged students in their learning.

Research Question 4 Results

The fourth RQ addressed: *How does the teacher perceive the PM as a means to engage students in critical thinking skills in a high school CTE program?* The fourth RQ used the teacher interview to answer this research question. Using the overarching themes of communication and problem solving.

During the teacher interview, Ms. Gardner noted, “it was fun watching them do their own problem solving, critical thinking, researching, and getting a lot of feedback from each other.” As the teacher stated, “in high school they [students] really do not want to think.” So, getting high school students engaged in their learning and activating critical thinking skills is a goal sought by many high school teachers. Therefore, Ms. Gardner did perceive the PM as a means for students to engage in critical thinking skills as they build their paper roller coaster.

Summary

In chapter 4, I presented data that was collected from the four data sources used to address the four RQs for this case study. I provided description of the setting, demographics, and detailed explanation of how the data was collected for each of the four data sources. I also, explained how I provided evidence of trustworthiness for this qualitative case study by implementing triangulation of data and member checking. Dependability was achieved by providing an audit trail for future studies to replicate.

Data analysis occurred by descriptive analysis of the student survey, content analysis of the student and teacher interviews, open coding for student mid-point and ending reflective journals as well as student and teacher interviews. Dominant themes were determined with the open coding for student mid-point and ending reflective journals and student and teacher interviews. Once the dominant themes were established, I was a able to determine the overarching themes for each research question. From these overarching themes, I was able to provide results for each of the four research questions. These results indicated that the PM did provide high school students with the means to motivate learning and activate critical thinking skills in a CTE program.

In Chapter 5, I will describe the findings and compare those findings with peer-reviewed literature which was addressed in Chapter 2. I will analyze and interpret the findings based on the context of the conceptual framework for this qualitative case study. Finally, I will provided a discussion of the limitation to the study, recommendation for further research, and describe the potential impact for positive social change this case study has on education.

Chapter 5: Discussion, Conclusions, and Recommendations

The purpose of this qualitative case study was to explore the role and function of the PM (Shepherd, 1998) as an instructional model for addressing motivation to learn and critical thinking among high school students in a (CTE). This case study was designed to examine how the PM impacted high school students' motivation to learn and critical thinking skills while in a CTE program. The research design that I chose was a case study because I wanted to learn the "particularity and complexity of a single case" (Stake, 1995, p. xi). The single case that I wanted to learn more about was an instructional learning model known as the PM. This study was designed to answer the following questions:

1. How does the PM impact high school students' motivation to learn when implemented in a CTE program?
2. How does the PM impact high school students' critical thinking skills when implemented in a CTE program?
3. How does the teacher perceive the PM as a means to motivate students to learn in a high school CTE program?
4. How does the teacher perceive the PM as a means to engage student in critical thinking skills in a high school CTE program?

I chose this study because there was limited research on the PM and there was not a research study conducted in a CTE program at the high school level. Since previous studies conducted by Shepherd (1998) and Vish (2013) indicated that the PM did motivate learning, I wanted to see if the PM motivated learning in high school age

students who participate in a CTE program. Shepherd's (1998) study found that elementary age students were motivated to learning while using the PM as an instructional learning model. Vish's (2013) study indicated that the PM did motivate high school students' learning in a social studies program. Also, Shepherd's (1998) study of the PM indicated that at the elementary level students did increase their critical thinking skills while the PM was used as the instructional model for a problem-based and project-based learning activity. Whereas, Vish (2013) did not find that the PM improved critical thinking skills among high school age students in a social studies program.

Since 21st century skills are required for the global workforce, having a learning model that captures the students interest and encourages them to think critically is valuable in the learning process. Merge this type of instructional learning model with a CTE program where trade skills are taught then the outcome of this merger should be students who are highly prepared for the demands for the 21st century workforce. Having some evidence that the PM does motivate learning and impacts critical thinking skills, as a researcher and educator, I wanted to provide additional evidence that students are motivated to learn and engage critical thinking skills when the PM is used as a learning model in a CTE program. This is the main reason for my interest in doing this case study because I wanted evidence that the PM which is an instructional learning model would inspires students to implement critical thinking skills and motivate them to learn while they participated in a high school CTE program.

Summary of Findings

Guided by the four RQs for this study, I used four data sources to collect data to answer those four research questions. Findings for this case study occurred by analyzing the collect data from the data sources of student surveys, student reflective journals, student interviews, and a teacher interview.

Motivating students to learn and getting them to think critically are a major obstacles educators strive to achieve throughout the school year. These same obstacles were concerns of the teacher who taught introduction engineering technology to 17 high school students which was part of a career and technology education (CTE) program. The teacher designed a paper roller coaster lesson that incorporated the PM (Shepherd, 1998) as its instructional learning model. Having the PM as the learning model, 21st century skills were incorporated within the lesson along with trade skills taught for that particular class. The 21st century skills included within the paper roller coaster lesson were "collaboration, communication, critical thinking, problem solving, creativity and innovation" (Partnership for 21st Century Learning, 2014).

In this qualitative case study, results from the document analysis, content analysis, and open coding data were comparable and were used to establish trustworthiness and a deeper understanding of the phenomenon, the PM, which was being explored in this case study. I used document analysis from archival student surveys and open coding and content analysis data from archival student reflective journals and student interviews for comparison of the data to address RQs 1 and 2. Research question 1 asked: *How does the PM impact high school students' motivation to learn when implemented in a CTE*

program? The document analysis supported the open coding data and content analysis that high school students in a CTE were motivated to learn using the PM (Shepherd, 1998). Additionally, RQ2 was seeking to address: *How does the PM impact high school students' critical thinking skills when implemented in a CTE program?* The document analysis supported the open coding and content analysis data that high school students in a CTE program were encouraged to implement critical thinking skills while using the PM.

Additionally, the document analysis, content analysis, and open coding findings for this case study revealed that students enjoyed learning because they were able to work collaboratively with peers while researching, designing, and constructing their paper roller coaster project. Students were able to think critically because they had complex problems to solve which required them to brainstorm, work collaboratively, and use their creativity during the design and construction of the paper roller coaster.

RQs 3 and 4 were addressed by the teacher interview. The qualitative data from the teacher interview revealed that the teacher perceived the PM as an effective means to motivate students' learning as well as engage students in critical thinking skills. A summarization of key findings for this qualitative case study suggests that high school students in a CTE program were motivated to learn and that students did engage critical thinking skills when the PM was used as an instructional learning model.

Interpretation of the Findings

Interpretation of the findings for the role and function of the PM on high school students' motivation to learn and critical thinking skills in CTE are based on the findings

to the conceptual framework and literature review described in Chapter 2. Using the four RQs as the framework for my interpretation of the findings, I was able to interpret the findings about how the role and function of the PM on high school students' impacted motivation to learn and critical thinking skills in CTE by using comparable data from student surveys, student reflection journals, student interviews, and a teacher interview.

The conceptual framework for this case study consisted of the constructivist paradigm, the framework for 21st century learning (Partnership for 21st Century Learning, 2014), and project-based and problem-based learning strategies. These conceptual frameworks are structural components of the PM (Shepherd, 1998) and are used for interpreting the finding for this qualitative case study based on each RQs for this case study.

Research Question 1

Research Question 1 asked *how does the PM impact high school students' motivation to learn when implemented in a CTE program?* Student surveys, student reflection journals, and student interviews were used as data sources to answer this question. By collecting these information, the researcher was able to gather insight into how students perceived the PM (Shepherd, 1998). Getting students intrinsically motivated to learn is a goal sought by educators and is essential in teaching students in the highly technological global society of the 21st century.

Problem-based and project-based learning strategies are part of the conceptual framework for this case study which are subparts of the structural components of the PM (Shepherd, 1998). Lam, Cheng, and Ma (2009) emphasized project-based learning

promotes and encourages intrinsic motivation. Findings from the student survey suggested that project-based as well as problem-based learning promotes intrinsic motivation. All 17 students in this study indicated on the student surveys that problem-based and project-based learning motivated them to learn. Key elements that lead student in this study to be intrinsically motivated were hand-on activities and collaboration with their peers. Dewey (1916) strongly believed that active learning motivated and encouraged students to be active participants in their learning, therefore, increasing cognitive development.

Both Ocak and Uluyol's (2010) and Lam, Cheng, and Ma's (2009) studies concluded that social collaboration in an active learning environment increased students' motivation. Also, the Buck Institute for Education (2012) reported that project-based learning allows students to work collaboratively which increases students' participation and excitement within their learning process. This was also explored in this study that collaboration was a contributing factor for students motivation to learn. Collaboration is a 21st century skill that employers are seeking in the workforce and is a category in the framework for 21st century learning (Partnership for 21st Century Learning, 2014). The PM allowed students to work collaboratively with partners, groups, and as a whole group while they built their paper roller coaster. Students reported reflection journals, as well as, in their interviews that working collaboratively with peers instead of having a lecture based lesson was much more exciting which motivated them to learn.

Research Question 2

Research Question 2 asked *how does the PM impact high school students' critical thinking skills when implemented in a CTE program?* Student surveys, student reflection journals, and student interviews were used as data sources to answer this question. Allowing students the opportunity to reflect over their learning encouraged students to think about their thinking (i.e., metacognition). Ennis (1996) emphasized that reflection during learning is critical to the development of critical thinking. Reflection is an important component of the PM (Shepherd, 1998) and students were provided ample opportunities to implement reflective thought throughout the paper roller coaster project. Students reported that they were able to think critically because the PM allowed for students to conduct research, brainstorm ideas, work collaboratively, and solve problems. These critical thinking skills were reported by the students during their interviews, written in their reflection journals, and indicated on their surveys as the skills they most often used during the paper roller coaster project.

Marin and Halpern (2011) and Reid and Anderson (2012) emphasized that students need the opportunity to practice implementing critical thinking skills so it will be an ordinary operation when needed. The students in this study were provided the opportunity to experience how-to think critically in the paper roller coaster activity. The data from this case study suggest that the PM is an effective learning model for students to develop critical thinking skills.

Research Question 3

Research Question 3 asked *how does the teacher perceive the PM as a means to motivate students to learn in a high school CTE program?* The teacher interview was used as the data source to answer this question. The teacher commented on how collaboration and technology were motivating factors as a means for the PM (Shepherd, 1998) to motivate students to learn.

Having students researching using technology provided opportunities for them to work independently as well as collaboratively. Papert (1993) noted that technology allowed students the option to work individually or with team members. Also, Papert (1993) reported that technology motivated students to learn which encouraged them to implement higher order thinking skills. In this study, technology played an important part in getting students motivated to learn because students had to conduct research, share their information that was gathered, and then apply that information. Consequently, students became collaborators with their peers to determine which information from their research would lead them to the best design for their paper roller coaster. Vijayaratnam (2012) noted that students need to practice how to work as a team which mimics real-world employment. Ms. Gardner provided her perspective that the students were actively engaged with their project-based and problem-based learning which created excitement for learning complex concepts.

In addition, the teacher provided her perspective that reflection or metacognition (i.e., thinking about thinking) was a major factor in getting students motivated to learn during the paper roller coaster lesson. Students were given opportunities to reflective

think during their learning process which does not happen often for many high school students. The structural design of the PM (Shepherd, 1998) encouraged students to reflective think about the new concepts they were learning and make adjustments in their approaches to solving the problem by sharing their thoughts with their partner and/or group. This promoted motivation because the students were actively collaborating with each other to design, build, and solve complex problems. Vygotsky (1978) reinforced that when students are learning a new concept, they must be provided the opportunity to have social interaction so that in depth thinking can take place which promotes engagement of the learning process. The data from this case study suggests that the PM is an effective means to motivate students to learn in a high school CTE program.

Research Question 4

Research Question 4 asked *how does the teacher perceive the PM as a means to engage student in critical thinking skills in a high school CTE program?* The teacher interview was used as the data source to answer this question. Ms. Gardner perceived that the PM did engage students in critical thinking skills in a high school CTE program because students were employing a variety of critical thinking skills throughout the entire paper roller coaster project. The teacher noted that problem solving, communication, and analyzing were the main critical thinking skills that students utilized, however, many other critical thinking skills were activated when needed.

Halpern (1998) suggested that students need to have real life experiences to learn how to effectively and efficiently integrate critical thinking skills while solving problems and/or dealing with a particular issue. The PM (Shepherd, 1998) incorporated 21st

century skills and encouraged students to engage in higher order thinking. Choy and Oo (2012) stressed how important it is to create a learning environment that provides time for reflective thinking and practice critical thinking. The PM does provide the time for reflection and critical thinking; therefore increasing students' critical thinking skills. The data from this case study suggests that the PM is an effective means to engage student in critical thinking skills in a high school CTE program

Limitations of the Study

There were several limitations to this qualitative case study. One limitation to this study was the small sample size. Only one teacher and one class was purposely selected for this study compared to five other CTE teachers from the high school who could have been included. Additionally, a total of 25 CTE teachers could have participated from the school district of the high school where this study took place. Also, time and location were delimitations because the original schedule and location had adjustments to accommodate end of the year testing for the entire high school. Any classroom that had a computer lab had to move to other classrooms. These classrooms only had one or two computers accessible to students. However, students were able to use their own electronic devices by using the wireless network at the high school. The participating teacher and students for this case study moved to the room across the hall and there were two student computers available for additional research. Prior to the move to the other classroom, the students had already conducted their research on their own computers and had written their student mid-point reflection in their digital journals.

Another limitation to this study was the data sources for this study. Having only one student interview session as well as one teacher interview session placed limitations on the students and the teacher expressing their knowledge and concerns about the PM (Shepherd, 1998). Additional interview sessions might have allowed students and the teacher to provide additional information about the PM as they were experiencing it during the actual project.

The final limitation was the possible bias resulting from the researcher working at the high school and working professionally with the teacher for fourteen years. As the researcher, I tried to counteract any possible bias by keeping a research journal which allowed me the opportunity to reflect over my actions to ensure that I was eliminating any potential biases throughout this case study.

Recommendations for Further Research

Educating students in the 21st century is very different from the educational methods of past centuries. Aside from the basics of educations, schools in the United States of America must keep abreast of all the technological advancements while ensuring that students are equipped with 21st century skills. These essential 21st century skills are “collaboration, communication, critical thinking, problem solving, creativity and innovation” (Partnership for 21st Century Learning, 2014). Liang (2012) stressed that higher institutions of learning are seeking learning models that challenge students while providing them with learning opportunities to develop 21st century skills. These 21st skills are essential for the success of the students to be competitive workers in the highly diverse and technological global workforce.

Two recommendations for further research are resulted from the finding of this case study. The first recommendation would be to replicate this study at the college level. Since the data from this case study suggest that the PM (Shepherd, 1998) was effective for motivating high school students to learn and encouraging them to implement critical thinking skills in a CTE program, it would be interesting to see if college students would have the similar experiences. Another recommendation for further research resulting from this case study would be to replicate this study at the middle school level as well as additional high schools. Comments from the students of this study expressed they liked to work collaboratively with partners and/or with groups but many had difficulty with communication within their teams. Both Neo and Neo's (2009) and Vijayaratnam's (2012) studies had similar results to this case study in that students need more development and practice working in teams. It would be interesting to see if the PM (Shepherd, 1998) strengthens communication and team building skills when implemented with different project-based and problem-based lesson throughout the entire school year at the middle school level.

Implications for Positive Social Change

The results from this qualitative case study have positive social change implications for high school CTE programs. This study provides a deeper understanding about the role and function of the PM (Shepherd, 1998) which is a learning model that is intended to motivate learning and activate critical thinking skills. Having a researched learning model with a structural framework that is based on project-based and problem-based learning strategies, constructivism paradigm, and framework for 21st century

learning (Partnership for 21st Century Learning, 2014) enhances the learning opportunities of high school students so they can develop essential skills to be successful workers in the highly dynamic 21st century global workforce. This study contributes to positive social change by providing teachers who teach in a high school CTE program a learning model that motivates learning and allows students to implement critical thinking skills. High school CTE teachers can add the PM to their teaching repertoire as a possible instructional learning model to motivate students to learn and encourage students to implement critical thinking skills.

Conclusion

The PM (Shepherd, 1998) is an instructional learning model that motivates learning and encourages critical thinking skills among high school students who participated in a CTE program. Insights gained from this qualitative case study provide a valuable instructional learning model that encourages students to implement critical thinking skills while engaging them in their learning process.

By looking at the conceptual framework of the PM (1998), it provides insight into the structural components that makes this learning model unique from other learning models (i.e., Odyssey of the Mind and Inquiry-Based Learning). The PM contains both project-based and problem-based learning strategies within its structural design. It is this difference makes the PM unique because the subparts of the PM pull from either the project-based or the problem-based learning strategy throughout the lesson. Since both learning strategies are incorporated in the PM design, students will experience a level of disequilibrium within their learning process.

If the lesson is designed according to the guidelines of the structural design of the PM (Shepherd, 1998), students will experience levels of disequilibrium as they seek solutions to their complex problems. It is during these moments of disequilibrium (i.e., level of frustration in learning) that students become motivated to learn because they are seeking answers and solutions to resolve the complex problem and return to state of equilibrium (i.e., level of knowing in learning). Berger (2008) and Piaget (1952) both highlighted that for in depth learning to occur, a level of frustration must be present. According to Berger (2008), it is at this level of frustration that a person is motivated because they want to seek a solution to the problem.

The teacher in this case study correctly implemented the PM (Shepherd, 1998) because this study provided insights when students were experiencing disequilibrium throughout the various stages of the paper roller coaster project. Consequently, the students did acquire equilibrium as they sought solutions to their complex problems. The desired learning outcome from the PM was achieved because students were motivated to learn and they used critical thinking skills to reach the state of equilibrium (i.e., a level of knowing in learning).

Having a learning model that embraced both project-based and problem-based learning, allowed for a higher degree of learning to take place. The PM (Shepherd, 1998) provided opportunities for academic rigor, reflective thought, collaboration, communication, problem solving, and critical thinking to occur while at the same time keeping the student engaged within their learning process. The learning environment in this case study was conducive to an authentic constructivist learning environment

because students were pioneers of their learning. Students conducted research to seek answers to their complex problems, worked collaboratively to design and build a paper roller coaster, and reflected over their learning when provided the opportunity to think about their thinking (i.e., metacognition). Students were able to bring their new gained knowledge back to the whole group and with confidence to determine how to best design a paper roller coaster that met the criteria for the finished project.

The purpose of this study was to explore the role and function of the PM (Shepherd, 1998) as an instructional model for addressing motivation to learn and critical thinking among high school students in a CTE program. The role the PM played in motivating students to learn and providing the opportunities for the students to use critical thinking skills was significant in this case study. The function of the PM has on improving learning among high school students in CTE is significant because the confidence and skills acquired from this learning model is a desired outcome that educators seek from learning models. The findings and conclusions that were gathered from this case study should enhance high school students' learning in a CTE program and provide the foundational skills necessary for students to be highly competitive members of the dynamic technological global workforce.

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Appendix A: The Probe Method

The Probe Method is a curriculum intervention designed by Dr. Glenn Shepherd (1998). The Probe Method (Shepherd, 1998) is a problem-based learning approach using group-investigation cooperative learning and the use of the Internet in finding and learning information regarding the presented problem. The assumption made in using this method is that students need to be guided through the process of solving a problem and be given ample opportunity to solve problems so they can learn to think critically and feel good about their abilities to solve problems. Instructional strategies found in other studies to help promote problem solving and critical thinking have been incorporated into this method.

The steps that were used in the Probe Method (Shepherd, 1998):

1. Identify the problem
2. Introduce issues related to the problem.
3. Understand the complexity of the problem.
4. Determine multiple factors that may influence the problem.
5. Read and collect information on factors related to the problem.
6. Discuss information gathered.
7. Critically analyze information gathered in small groups.
8. Summarize most important information.
9. Present information to larger group.
10. Read and collect additional information, as needed.
11. Discuss new information.
12. Discuss possible solutions.
13. Summarized in written paper the solution selected.

Students work in cooperative groups to discuss the problem, analyze information, and brainstorm possible solutions and strategies. Students work individually and in pairs to read and collect information related to the problem. Students use the Internet as their primary source of information although more traditional sources of information may also be used. Students meet back in small groups to discuss findings and further critically analyze information found.

Below is an outline of the steps used in the Probe Method (Shepherd, 2012) in solving a problem:

I. Provide students with a set of information about the unit. Students should be given the objectives of the unit along with a list of required readings, exercises, and assignments that relate to the unit of study.

II. Identify a real-world problem that relates to the unit of study and present an introduction on issues related to the problem to the whole class. Some suggestions are:

A. Introduce issues of the problem via short lecture presentation or online presentation.
B. Show a video or other visuals to expand on the introduction of the problem.
C. Have a guest lecturer or online expert to present issues. Have students discuss topic and define problem.
D. Have students discuss topic and define problem.

III. Examine the problem as a whole class in a teacher-led discussion. Discussions can be face-to-face or electronic communications.
    A. Large group discussion
        1. Verbalize the problem.
        2. Discuss different sides of the problem.
        3. Consider the complexity of the problem.
        4. Develop a few possible solutions to the problem.
        5. Develop a plan of action to solve the problem.
            a. Decide on the types of information (areas) needed to better understand the problem.
            b. Establish small groups of students (2 to 4). If distance learning groups are involved, divide each site into small groups as well so that students work in virtual study groups.
            c. Determine what area each small group will research.

IV. Gather data and put appropriate data in a presentation format.
    A. Each group collects data on their chosen area.
        1. Use CD-ROM databases, electronic encyclopedias, atlases, and other computer software programs containing related information.
        2. Use Internet and World Wide Web to conduct searches on the topic to find a variety of sources of related information. Provide several very good sites with resources, if needed.
        3. Use conventional library skills (card catalogs, periodical guides, encyclopedias, books, magazines, films) to find other sources.
        4. Compile information individually as assigned by the small group.
    B. Small group decides what data is most relevant, weeds out some data not pertinent to the problem after discussing their "new" understanding of the given problem and how the data might help in solving the problem, and then summarizes the most important data.
    C. The "key" data is entered into electronic form (using word processors, desk-top publishing, databases, spreadsheets, authoring or presentation programs, and graphic programs). Graphic programs can be used to create illustrations, maps, and graphs and then these graphics can be imported into other software programs. Some data might be put online as web pages or links to them online.

V. Small groups present data.

A. Each small group presents their data to the larger group. Information is presented in electronic format using web-authoring or presentation programs.
B. Small groups also discuss their interpretation of the problem and how the data might help in solving the problem.

VI. Large group discussion, teacher-led
A. Smaller groups and individuals verbalize their understanding of the other groups' data and interpretations.
B. Verbalize criticisms of others' interpretations.
C. Distance cooperative groups can discuss the issues by using Internet. Have one group at a distant site communicate to a specified group at another site about their ideas. Several classrooms could be working together on one probe method project at locations around the world to refine ideas. Wiki spaces can be set up for students to communicate, share ideas, and work. Blogs can be used for discussion of the topic with others at a distance.

VII. Simulation and/or CBI (computer-based instruction) program, if available, either software or online. This would be optional if such software was found to be appropriate.
A. Students work on a CBI program geared to their topic/problem.
B. Students work on the program in a small cooperative group.
C. Small group discusses the game and its relationship to solving the problem.

VIII. Solutions to the problem
A. Small groups discuss and brainstorm solutions to the topic/problem.
B. Small groups summarize their solutions, using electronic means. Students might create a website, if appropriate. They might also build physical models, if appropriate.

IX. Summary of solutions
A. Small groups present their solutions to the larger group. Again, they should use electronic web authoring or presentation software.
B. Large group critically discusses others' solutions and try to come to some agreements.
C. Individuals write a short essay in which they explain what solutions to the problem they most support and why. Individuals could choose to publish their personal thoughts on a web site as an optional activity.

X. Final assessment of unit. Assessment of the unit should come from work in the problem-solving assignments, end-of-unit tests (if any), and any other assignments associated with the unit of study. Self-assessment measures would be quite appropriate in a constructivist approach such as this one.

Appendix B: Student Survey

For the following statements circle a number (1 through 5) to show how much you agree or disagree to the statement.

1 – Strongly Agree
2 – Agree
3 – Neutral (no strong feelings either way)
4 – Disagree
5 – Strongly Disagree

1.	The PM was helpful for me to think critically.	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
2.	I enjoyed learning in a project-based and problem-based learning environment.	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
3.	I understand more about thinking critically because of the skills I learned using the PM.	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
4.	I enjoyed working collaboratively with a partner and a group to research, design, and build a paper roller coaster.	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
5.	I enjoyed building a paper roller coaster because the PM made learning more exciting.	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
6.	My experience gained from learning to think critically of how-to build a paper roller coaster provided me with more confidence.	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
7.	The PM made it more difficult to design a paper roller coaster.	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
8.	In general, I think I am better able to think critically than before using the PM.	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
9.	I like working individually, I did not enjoy working collaboratively with a partner and a group to research, design, and build a paper roller coaster.	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree

10. I feel, I did not acquired adequate skills to think critically by using the PM.	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
11. The PM was not helpful in motivating me to think critically.	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree
12. I did not enjoy building a paper roller coaster because the PM did not make learning more exciting.	1 Strongly Agree	2 Agree	3 Neutral	4 Disagree	5 Strongly Disagree

Appendix C: Student Reflective Journal Prompts

A student reflection journal is required for the mid-point and end of your PM project-based lesson of a paper roller coaster. Please answer the following questions when instructed by the teacher.

Mid-point of project questions:

- What problems, if any, did you encounter with researching topics for solutions to the design problem of the paper roller coaster?
- What part of the PM do you enjoy working on?
- What part of the PM do you NOT enjoy working on?
- How does the PM make learning more exciting than a lectured based lesson?
- How do you like working collaboratively with a partner while researching? Explain in detail any issues negative or positive do you experience when working with a partner while researching.
- How do you like working collaboratively with a group? Explain in detail any issues negative or positive do you experience when working with a group while determining the best research for solving the problem for designing and building the paper roller coaster.
- What challenges are you faced with in designing, building, and testing the paper roller coaster? Explain if you experience any moments of frustration, success, doubt, failure, or success during these challenges.
- How did you feel today about your progress for meeting the upcoming deadline for completing the paper roller coaster?
- What critical thinking skills have you used so far in designing, building, and testing the paper roller coaster?

End of the project questions:

- What problems, if any, did you encounter with researching topics for solutions to the design problem of the paper roller coaster?
- What part of the PM did you enjoy working on through out the project?

- What part of the PM did you NOT enjoy working on through out the project?
- How did the PM make learning more exciting than a lectured based lesson?
- How do you like working collaboratively with a partner while researching? Explain in detail any issues negative or positive did you experience when working with a partner while researching.
- How do you like working collaboratively with a group? Explain in detail any issues negative or positive did you experience when working with a group while determining the best research for solving the problem, designing, and building the paper roller coaster.
- What challenges did you face designing, building, and testing the paper roller coaster? Explain in detail if you experienced any moments of frustration, success, doubt, failure, or success during these challenges.
- How do you feel about your progress for completing the paper roller coaster?
- What critical thinking skills did you use in designing, building, and testing the paper roller coaster?

Appendix D: Student Interview Questions

1. Did the PM motivate you to learn? Why or Why not?
2. What part of the PM, if any, motivated you the most?
3. What part of the PM, if any, motivated you the least?
4. How did the integration of technology during the implementation of the PM motivate you to learn?
5. Did the PM helped you to think critically? Why or Why not?
6. What critical thinking skills did you implement the most during the PM?
7. What critical thinking skills did you implement the least during the PM?
8. What kind of critical thinking strategies did you implement when designing and building the paper roller coaster?
9. What part of the PM, if any, presented a challenge for you to think critically?
10. What would you suggest to your teacher or other teachers on increasing student's motivation to learn by using the PM?
11. What would you suggest to your teacher or other teachers on increasing student's critical thinking skills by using the PM?

Appendix E: Teacher Interview Questions

1. Did the PM help motivate students to learn? Why or Why not?
2. What part of the PM, if any, motivated students the most?
3. What part of the PM, if any, motivated students the least?
4. How did the integration of technology during the implementation of the PM motivate students to learn?
5. Did the PM help students to think critically? Why or Why not?
6. What critical thinking skills did the students implement the most during the PM?
7. What critical thinking skills did the students implement the least during the PM?
8. What kind of critical thinking strategies did the students implement when designing and building the paper roller coaster?
9. What part of the PM, if any, presented a challenge for students to think critically?
10. What would you suggest to other teachers on increasing student's motivation to learn by using the PM?
11. What would you suggest to other teachers on increasing student's critical thinking skills by using the PM?