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Project-based Learning as a Means for Meeting the Needs of 21st Century Students in Common Core States

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by

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Declaration of Originality

I do hereby declare and attest to the fact that this is an original study based solely upon my own scholarly work here at Lindenwood University and that I have not submitted it for any other college or university course or degree here or elsewhere.

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Abstract

The call for the reform of public education in the United States of America has come from stakeholders of all kinds. This study compares two seemingly opposing approaches to the reform of public education. The bureaucratic approach is represented by the mass adoption of the Common Core State Standards (CCSS). The grassroots approach is represented by the International Society for Technology in Education Standards for Students (ISTE Standards-S). It was important to identify and analyze an instructional practice with enough potential rigor to meet the demands of both the CCSS and the ISTE Standards-S. The study analyzed the potential ability of Project-based learning (PBL) to meet the needs of both approaches. From the varied literature on PBL, six "Common Components" were identified and rewritten as standards using the revised Bloom's taxonomy. Once the Standards of PBL were written, all three sets of standards were quantified using a combination of the revised Bloom's Taxonomy and Gallia's Synonyms List. Following quantification of the standards, they were compared using a single factor ANOVA to determine if there was a difference between the cognitive processing levels of each set of standards. The cognitive processing levels of the Standards of PBL were found to be significantly higher than that of the CCSS. However, no significant difference was found between the Standards of PBL and the ISTE Standards-S. These findings support the claim that using the Standards of PBL in the classroom will meet the cognitive processing demands of the CCSS. The results of this study will allow teachers in Common Core states to utilize the instructional strategy of PBL as a means for meeting the cognitive processing needs of the CCSS.

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List of Abbreviations

CCSS – Common Core State Standards

ELA – English Language Arts

ESEA – Elementary and Secondary Education Act

GLEs – Grade Level Expectations

ISTE – International Society for Technology in Education

ISTE Standards-S – International Society for Technology in Education Standards for Students

MA – Mathematics

MODESE – Missouri Department of Elementary and Secondary Education

NCLB – No Child Left Behind

P21 – Partnership for 21st Century Skills

PBL – Project-based Learning

PISA – Programme for International Student Assessment

Chapter One: Introduction

The onset of the 21st century produced many changes in America (Trilling & Fadel, 2009), but the adoption of the Common Core State Standards (CCSS) has been one of the most contentious and divisive (Shuls, 2013). While many reformers supported the shift to higher, more rigorous standards (Association for Supervision and Curriculum Development (ASCD), 2012; Calkins, Ehrenworth, Mary, & Lehman, 2012; Expect More Achieve More Coalition, 2013), many others believe the focus should have been on transforming education from an industrial, one-size-fits all model to an individualized model focused on teaching the skills students needed to navigate an uncertain future (Robinson, 2011; Schwahn & McGarvey, 2011; Zhao, 2009).

There are some researchers, however, who believed it was the time for both (Bender, 2012; Hallerman, 2013; Markham, 2012). These reformers believed that, given the right instructional strategy, educational professionals had the ability to rigorously teach students to the mastery level of the standards while simultaneously developing the skills requisite for success in the 21st century (Marzano & Heflebower, 2012). Many of these researchers believed Project-based Learning had the potential to bridge this gap and link these two viewpoints (Ross, 2012).

Background of the Study

Since 2009, the numbers 25, 14, and 17 have remained at the forefront of education reform in the United States. These three numbers represent the rankings of U.S. students' scores from the 2009 Programme for International Student Assessment (PISA) achievement test relative to 64 other tested countries (Organisation for Economic Co-operation and Development, 2010). These rankings represent how U.S. students' knowledge in the areas of math, reading, and science respectively, measure up against these 64 other countries.

Unfortunately, three new numbers have recently emerged based on the scores of the 2012 PISA achievement test. These new numbers are 26, 17, and 21 (Organisation for Economic Co-operation and Development, 2013). These world rankings in math, reading, and science—much like *The Coleman Report*, which interpreted survey data to determine inequality in racially segregated schools in the 1960s (Coleman, 1966) and *A Nation at Risk*, which referenced data comparisons of student achievement from academic tests administered in the 1970s (National Commission on Excellence in Education, 1983)— have become the catalyst for a new generation of education reform.

In response to public outcry for education reform in the United States, two distinct reform pathways have emerged. These include the bureaucratic path, exemplified by the mandated Common Core State Standards (CCSS) (Shuls, 2013), and the grassroots path, exemplified by the 21st century skills movement (International Society for Technology in Education, 2007; Partnership for 21st Century Skills, 2014). While both pathways take very different approaches and travel in seemingly dissimilar directions, they both begin with the same idea. Both pathways begin with the concept that public education can and must change (International Society for Technology in Education, 2012; National Governers Association Center for Best Practices, Council of Chief State School Officers, 2008; U.S. Department of Education, 2010).

In the bureaucratic path of education reform, politicians used scores and rankings like those from the PISA to push the agenda of standards-based reforms and test-driven accountability (Bush, 2013). Grassroots education reformers, on the other hand, have argued against the standards-based accountability model of public education, citing that it adversely affects creativity and innovation, individual thought, and self-reliance (Gray, 2013; Robinson, 2009; Zhao, 2012). These researchers have instead focused on turning public attention on reforms that teach skills which are valuable in the 21st century workplace over static academic content and accountability (Barell, 2008; Boss, 2012; Zhao, 2009).

The CCSS movement and the International Society for Technology in Education Standards for Students (ISTE Standards-S) represent the latest attempts to reform public education in the United States. The CCSS represented the bureaucratic approach (Shuls, 2013). The ISTE Standards-S represented the grassroots approach (Boss, 2012). However, the framers of each set of standards have worked to create standards that seem to be focused on similar outcomes and attempt to bridge the gap between standards of knowledge and the skills necessary for the 21st century workplace (International Society for Technology in Education, 2012).

According to the CCSS (2013) webpage, to date “forty-five states, the District of Columbia, four territories, and the Department of Defense Education Activity have adopted the Common Core State Standards” (para. 1). In June 2010, the Missouri State Board of Education adopted the CCSS in preparation for application for the ESEA flexibility waiver (Missouri Department of Elementary and Secondary Education, 2012) which was accepted on June 29, 2012 (Potter, 2012). The Missouri Department of Elementary and Secondary Education plans for the CCSS to be fully implemented in the 2014-2015 school year (Missouri Department of Elementary and Secondary Education, 2013).

According to the *Standards-Setting Criteria*, the National Governers Association Center for Best Practices and the Council of Chief State School Officers (2010) developed the CCSS to lay a framework for academic success in “credit-bearing, college-entry courses and in workforce training programs” (p. 1). More evidence of this sentiment can be found in the introduction to the CCSS document (2010), wherein the developers summed up the fundamental philosophy of the CCSS initiative by stating the following:

> To be ready for college, workforce training, and life in a technological society, students need the ability to gather, comprehend, evaluate, synthesize, and report on information and ideas, to conduct original research in order to answer questions or solve problems, and to analyze and create a high volume and extensive range of print and nonprint texts in media forms old and new. The need to conduct research and to produce and consume media is embedded into every aspect of today’s curriculum. In like fashion, research and media skills and understandings are embedded throughout the Standards rather than treated in a separate section. (National Governers Association Center for Best Practices, p. 4)

The writers of the CCSS created the standards using a set of criteria which expressly stated, “The standards will include high-level cognitive demands by asking students to demonstrate deep conceptual understanding through the application of content knowledge and skills to new situations” (National Governers Association Center for Best Practices, Council of Chief State School Officers, 2010, p. 2). These more rigorous standards require teachers to develop more rigorous teaching strategies (Missouri Department of Elementary and Secondary Education [MODESE], 2012). The CCSS require a shift in instruction from a "fill-in-the-blank, answer-the-questions, read-the-paragraph curriculum" to a 'thinking curriculum' focused on 'higher-level comprehension skills' (Calkins et al., 2012, p. 9).

According to the *ESEA Flexibility Waiver Request*, the Missouri Department of Elementary and Secondary Education (2012) identified multiple areas of increased rigor in the CCSS when compared to the previous Missouri standards. To test this assertion, Lindenwood doctoral candidate Toni Gallia (2012) quantified the revised Bloom's Taxonomy action verbs and synonyms in the CCSS and the previous Missouri grade level expectations. Gallia (2012) initially determined there was "no measurable difference in overall cognitive thinking skills between the MO GLEs [Missouri Grade Level Expectations] and the CCSS" (p. 120). Gallia decided to take her analysis a little further and identified the frequency of higher-level objectives in the CCSS as well as the Missouri Grade Level Expectations. In this analysis, Gallia (2012) found "of all the grade levels in both ELA [English Language Arts] and MA [Math] included in this study 70% showed CCSS as having more higher-level thinking objectives than the MO GLEs [Missouri Grade Level Expectations]" (p. 129).

The National Governors Association and Council of Chief State School Officers clearly identify that the CCSS were developed with a focus on rigor and the "application of knowledge through high-order skills" ("*Frequently Asked Questions*," 2010, para. 12). The results of Gallia's study seem to support this intention. However, many critics of the CCSS believe that any standards-based reform remains short-sighted and stifling to the needs of the 21st century (Zhao, 2009). Reformers, like Yong Zhao (2012), held that rather than creating "homogenization…through increased national control of what children should learn" (p. 27), educators should be teaching skills which are entrepreneurial in nature such as identifying problems, developing solutions, and selling those solutions. The Partnership for 21st Century Skills (P21) (2009) agreed, contending that public education needs to widen its focus to include the skills of creativity, communication, collaboration, and critical thinking, which represent "the knowledge, skills, and expertise students should master to succeed in work and life in the 21st century" (p. 2).

In 1998, the International Society for Technology in Education (ISTE) attempted to address this need by developing a set of standards designed to evaluate the "skills and knowledge students need to learn effectively and live productively in an increasingly global and digital world" (*Standards for Students*, 2012, para. 1). According to the CEO of ISTE, Don Knezek (2007), their standards were intended to give educators a picture of what skills students need to be successful in the 21st century. The ISTE Standards-S focus on six broad categories including the following:

- creativity and innovation;
- communication and collaboration;
- research and information fluency;
- critical thinking, problem solving, and decision making;
- digital citizenship; and
- technology operations and concepts (International Society for Technology in Education, 2007, pp. 1-2)

Standards were developed and adopted, but standards are only intended outcomes (Ross, 2012). The CCSS and ISTE Standards-S may offer educators "a consistent, clear understanding of what students are expected to learn" (National Governers Association Center for Best Practices, Council of Chief State School Officers, 2013, para. 4). However, educators in the United States need instructional strategies which allow them to meet the higher level concepts built into the CCSS while simultaneously preparing them for the workplace of the future (Trilling & Fadel, 2009). As stated by the authors and researchers responsible for revising Bloom's original taxonomy for teaching and learning, Anderson and Krathwohl (2001), "Instructional activities, if chosen wisely and used properly, lead to the achievement of stated objectives" (p. 17). Is it possible for teachers to teach to the CCSS in such a way that they also teach the skills needed for success in the 21st century?

While many reformers have taken seemingly opposing stances – some for common standards mastery instruction and some for 21st century skill instruction – other reformers, such as David Ross (2012), the Director of Teacher Professional Development and Dean of National Faculty for the Buck Institute for Education, believed that the adoption of the CCSS may have created a unique opportunity for educators to teach both (Ross, 2012). Ross believed the CCSS, which emphasize academic ends rather than means (National Governers Association Center for Best Practices, Council of Chief State School Officers, 2010), allows for educator flexibility in designing instructional strategies. With the right instructional strategy, teachers can simultaneously teach students to the mastery level of the standards while teaching the skills needed for students to be college and career ready in today's workplace (Ross, 2012).

Researchers, such as Sarah Hallerman (2013), the Curriculum Development Manager for the Buck Institute for Education and frequent Edutopia contributor, have felt an instructional strategy known simply as Project-based Learning (PBL), has the potential to bridge the gap between standard mastery and skill acquisition. She stated that, "The Common Core has embedded within it some big ideas that shift the role of teachers to curriculum designers and managers of an inquiry process" (Hallerman, 2013, para. 1). In short, as Ross (2012) asserted, "The Common Core is the 'what,' PBL is the 'how'" (para. 16).

PBL is an inquiry-based instructional approach which puts students in control of their learning. In his book, *Who Owns the Learning?*, November (2012) argued that educators should "change the culture of learning, giving students much more responsibility by encouraging them to be collaborators, contributors, and researchers" (p. 14). This approach allows students to guide their own inquiry into a problem, work with others to solve the problem, and create a culminating project which has value in the real world beyond the classroom (Barell, 2007; Barron & Darling-Hammond, 2008; Boss & Krauss, 2007; Larmer & Mergendoller, 2010; Savery, 2006).

Teachers who use PBL in their classrooms have the potential to increase student engagement and motivation (Barell, 2007; Barron & Darling-Hammond, 2008; Boss & Krauss, 2007; Larmer & Mergendoller, 2010; Savery, 2006). While engagement and motivation are important, are teachers using PBL able to meet the "rigorous content and applications of knowledge through higher-order skills, so that all students are prepared for the 21st century" as stated in the CCSS Standard Setting Criteria (National Governers Association Center for Best Practices, Council of Chief State School Officers, 2010, p. 1)? John Larmer, the Editor in Chief of the Buck Institute for Education, believed that many teachers who professed to use PBL in the classroom only used entry level, culminating projects to teach concepts and thus missed out on the depth of understanding true PBL could provide (Larmer & Mergendoller, 2010).

The CCSS identify what college and career ready students need to know and be able to do in the areas of ELA and MA when they graduate from high school. However, there are still skills and concepts students need to master for success in the 21st century workplace (Trilling & Fadel, 2009). In the *Standards Setting Considerations* document, the National Governers Association for Best Practices and the Council of Chief State School Officers (2013) acknowledged this by stating:

> These documents are not an attempt to demonstrate everything that a student should learn; rather, we have focused on two areas – English-language Arts and Mathematics. The standards have incorporated 21st century skills where possible. They are not inclusive of all the skills students need for success in the 21st Century, but many of these skills will be required across disciplines. (p. 2)

The potential ability of teachers using the PBL approach to meet the 21st century needs of students was also evaluated due to the importance placed on 21st Century Skills by both the framers of the CCSS and education reformers like Zhao. The International Society for Technology in Education, in their *Position Statement on the Common Core State Standards* (2012), asserted their standards:

> ...help educators build a firm foundation for teaching with technology and further the development of many of the same 21st century skills set Fourth by the Common Core State Standards, such as problem solving, critical thinking, creativity and collaboration skills. (para. 3)

The suggested correlation between the CCSS and ISTE Standards-S led to the utilization of the same cognitive rigor coding process to assess the potential for teachers using the PBL method to reach the cognitive processing level of the ISTE Standards-S. These 21st century standards were developed to evaluate "the skills and knowledge students need to learn effectively and live productively in an increasingly global and digital world" (ISTE, 2007, p. 1). These comparative findings are included in this report.

Due to the controversial nature of the standards movement versus the 21st century skills movement, a study to examine each set of standards through the lens of an instructional strategy was deemed timely. This study measured the potential ability of teachers utilizing PBL to meet the cognitive rigor demands of the CCSS in kindergarten through fifth grade. Both the ELA and MA standards for these grade levels were analyzed using a cognitive rigor coding system of Bloom's revised taxonomy to determine if the use of PBL proved rigorous enough to adequately prepare students for college and career according to the CCSS.

Purpose of the Study

Politicians have called for more rigorous standards (Bush, 2013) and business leaders are demanding more work-related skills (Massachusetts Business Alliance for Education, 2006). Due in large part to these factors, the focus of this study was the analysis and comparison of the cognitive processing language of the CCSS, the ISTE Standards-S, and the Standards of PBL. Through the analysis, it was determined whether the potential cognitive level of the PBL method met or exceeded the level of cognitive processing as is required for mastery of the CCSS and ISTE Standards-S. The findings of this study will help educational professionals who are looking for effective strategies to teach students 21st century skills in states which have adopted the CCSS.

Many teachers have used instructional strategies which they felt were suited to the straightforward nature of the "industrial model" (May, 2011, p. 1) of public education. These teachers echoed the fear of educational accountability through the narrow lens of achievement testing (Trilling & Fadel, 2009). The adoption of the CCSS (Potter, 2012) combined with the outcry for an educational experience grounded in 21st century skills (Boss, 2012; Partnership for 21st Century Learning, 2009) has led to an exploration of instructional strategies which might be able to do both (Zhao, 2012). The instructional strategy of PBL was selected for this study as a possible strategy with potential to reach the cognitive processing levels of the suggested 21st century skills of the ISTE Standards-S and the CCSS.

Educational researcher John W. Thomas (2000) found in his review of research on PBL, there is a "diversity of defining features coupled with the lack of a universally accepted model or theory of Project-Based Learning [which] has resulted in a great variety of PBL research and development activities" (p. 1). To create a model which could be used in this study and replicated for future studies, a review of the varied literature on PBL was conducted. From this review, a common model of PBL was synthesized which includes the components most frequently seen in each description of PBL. Six components were identified across the literature on PBL. From those six components, six Standards of PBL were synthesized and used for comparison.

Conceptual Framework

To determine whether teachers using PBL as an instructional strategy would be able to meet the cognitive demands of the CCSS as well as the higher order skills outlined in the ISTE Standards-S, a way to compare the three was needed. Since much of the literature surrounding the CCSS alludes to increased cognitive rigor, comparative analyses of cognitive rigor were deemed appropriate. The action verbs were used to quantify the cognitive rigor of the standards as "the verb generally describes the intended cognitive process" (Anderson & Krathwohl, 2001, p. 4).

This technique, which was first developed by Toni Gallia (2012), was used to quantify and compare the Standards of PBL with the CCSS and the ISTE Standards-S (Gallia, 2012). The Revised Bloom's Taxonomy and Gallia's synonyms list were used to assign numerical values to the cognitive language at which each of the standards were written. Once all three sets of standards were organized and quantified, comparisons and analyses were conducted.

Research Questions and Hypotheses

The following questions guided this study:

1. Do the potential cognitive processing levels of the Standards of PBL meet or exceed the cognitive processing demands of a majority of the CCSS in grades K-5?
2. What is the difference in the mean cognitive processing levels of the CCSS and the Standards of PBL in grades K-5?

3. Do the potential cognitive processing levels of the Standards of PBL meet or exceed the cognitive processing demands of a majority of the ELA CCSS in grades K-5?
4. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL in grades K-5?
    a. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the kindergarten grade level?
    b. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the 1st grade level?
    c. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the 2nd grade level?
    d. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the 3rd grade level?
    e. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the 4th grade level?
    f. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the 5th grade level?
5. Do the potential cognitive processing levels of the Standards of PBL meet or exceed the cognitive processing demands of a majority of the MA CCSS in grades K-5?
6. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL in grades K-5?

a. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the kindergarten grade level?

b. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the 1st grade level?

c. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the 2nd grade level?

d. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the 3rd grade level?

e. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the 4th grade level?

f. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the 5th grade level?

7. Do the potential cognitive processing levels of the Standards of PBL meet or exceed the cognitive processing demands of a majority of the ISTE Standards-S?

8. What is the difference in the mean cognitive processing levels of the ISTE Standards-S and the Standards of PBL?

The null hypotheses stated there would be no measurable difference between the overall cognitive processing levels of the Standards of PBL and the cognitive processing language of the CCSS in the content areas of ELA and MA in grades K-5 and between the Standards of PBL and the ISTE Standards-S using the quantified language defined by the revised Bloom's Taxonomy (Anderson & Krathwohl, 2001) and adapted by Gallia (2012).

Limitations

One possible limitation of the study could be the choice of Bloom's Revised Taxonomy as the basis for determining the cognitive rigor of the standards. This could be considered a limitation as there are other educational researchers and philosophers who have produced different models of cognitive thinking which some may consider more valid. Such models could include Depth of Knowledge (Webb, 1997) or the *Rigor/Relevance Framework* (International Center for Leadership in Education, 2013).

Another possible limitation of the study could be the dependence on following a model of PBL not universally accepted as the definitive version of PBL. Experts in the area of PBL may suggest their particular nuances of PBL, which are left out of the chosen model, are essential to effective PBL in the classroom. For instance, all models of PBL refer to the development of a problem; however, some believe the problem must be completely generated by the students (Markham, 2012), while others believe the teacher should set the problem (Bender, 2012). Another example in difference of approach might be that Boss and Krauss (2007) believed technology must be used in the PBL process for it to be an effective 21st century teaching strategy, while most other sources do not mention technology at all.

Definition of Terms

Bloom's Revised Taxonomy. Krathwohl (2002), determined the taxonomy was: "A hierarchy in the sense that the six major categories of the Cognitive Process dimension are believed to differ in their complexity, with remember being less complex than understand, which is less complex than apply, and so on" (p. 215).

Cognitive process. The "framework includes six categories of processes – one most closely related to retention (Remember) and the other five increasingly related to transfer (Understand, Apply, Analyze, Evaluate, and Create)" (Anderson & Krathwohl, 2001, p. 66)

Cognitive rigor. According to the International Center for Leadership in Education (2013), cognitive rigor is: "Learning in which students demonstrate a thorough, in-depth mastery of challenging tasks to develop cognitive skills through reflective thought, analysis, problem-solving, evaluation, or creativity" (p. 4).

Common Core State Standards (CCSS). The standards present "a consistent, clear understanding of what students are expected to learn … The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers (National Governers Association Center for Best Practices, Council of Chief State School Officers, 2013, para. 1).

International Society for Technology in Education Standards for Students (ISTE Standards-S). These are "the skills and knowledge students need to learn effectively and live productively in an increasingly global and digital world" (International Society for Technology in Education, 2007, p. 1).

Project-based learning (PBL). The type of learning is "defined as using authentic, real-world projects, based on a highly motivating and engaging question, task, or problem, to teach students academic content in the context of working cooperatively to solve a problem" (Bender, 2012, p. 7).

Standards of PBL. Standards created through a synthesis of research on project based learning. In an effort to create a benchmark for comparison, six components of

PBL which are consistent across the existing literature were identified. The revised Bloom's taxonomy was then used to focus these components into six actionable standards in an effort to quantify the cognitive processing levels of each component.

21st Century Skills. These are "the essential skills for success in today's world, such as critical thinking, problem solving, communication, and collaboration" (Partnership for 21st Century Learning, 2009, p. 1).

Summary

Due to numerous contributing factors, many believed public education was in need of reform; therefore, two pathways for reform have been identified. The bureaucratic pathway was a pathway to reform which relied on top down legislation in order to enact sweeping changes to education (Shuls, 2013). The grassroots pathway was characterized by a non-threatening, voluntary method which was shared with the public for those educators who were interested (Kuyatt, 2011). The grassroots pathway began in the individual classroom.

Standards were written, which were used to represent both pathways. The CCSS exemplified the bureaucratic pathway of reform and were developed and legislatively adopted by many states (National Governers Association Center for Best Practices, Council of Chief State School Officers, 2013). The ISTE Standards-S were used to exemplify the grassroots approach to reform and were developed and shared with the public for anyone and everyone to use (International Society for Technology in Education, 2007). The CCSS were developed by a large group of educators and politicians. They were internationally benchmarked to ensure global competitiveness (National Governers Association Center for Best Practices, Council of Chief State School

Officers, 2010). Gallia (2012) confirmed that the CCSS were written at a more rigorous level than previous state standards.

Critics believed the CCSS were not the answer to true reform. They believed the CCSS were missing key aspects for the complete development of students (Shuls, 2013). These reformers believed standards-based legislative reforms with an emphasis on high stakes testing were missing the key skills of 21st century (Zhao, World class learners, 2012).

The ISTE developed the Standards-S to fill this void. The ISTE Standards-S are focused on key 21st century skills which students need to be successful in the 21st century workplace (International Society for Technology in Education, 2012). The Standards-S focus on skills, such as critical thinking, collaboration, communication, and creativity (International Society for Technology in Education, 2007).

Exploration of both sets of standards led to the question: How can educators meet the standards legislated on them, while still teaching the key 21st century skills outlined by the ISTE? Many education reformers have referenced PBL as one possible strategy for meeting the high stakes needs of students. PBL was found to allow students to focus on learning standards in a highly collaborative and student directed way (Barron & Darling-Hammond, 2008). Thus, students were able to learn the content while still developing the 21st century skills. This study examined PBL and determined if it was able to meet the needs of both sets of standards.

In Chapter Two, current literature related to the CCSS, 21st century skills acquisition, and the PBL teaching method were reviewed. Chapter Three includes the process of the study, including the data collection and analysis process, how the study was designed, and the statistical methodology employed. The results and analyses of the data were discussed in Chapter Four. In Chapter Five, the data were extrapolated and the implications and recommendations were discussed.

Chapter Two: The Literature Review

Many reformations of public education have occurred throughout history. The latest reform movement involved the Common Core State Standards (CCSS) with an emphasis on college and career readiness. While many praised the increased rigor of the standards (Achieve, 2013), many teachers are struggled to find instructional strategies which can successfully lead students to mastery of the higher standards (Brennan, 2013).

Implementation of the CCSS is a challenging prospect for educators as it is less about "thinking out of the box… [and more] about transforming the box itself" (Achieve, 2013, p. 4) Thus, some reformers have identified Project-based Learning (PBL) as a teaching strategy rigorous enough to meet the standards (Ross, 2012), while simultaneously teaching students valuable 21st century skills which are increasingly needed in the modern workplace (National Governers Association Center for Best Practices, Council of Chief State School Officers, 2008). This chapter contains a review of literature related to the CCSS, 21st century skills, and PBL.

The Common Core State Standards and Education Reform

The current model of public education is reflective of the industrial age of United States development (May, 2011; Robinson, 2011; Trilling & Fadel, 2009). The onset of technology has created a "world without borders" (National Governers Association Center for Best Practices, Council of Chief State School Officers, 2008, p. 1). This, combined with an enlightened academic and corporate worldview (National Governers Association Center for Best Practices, Council of Chief State School Officers, 2008), has created an imperative to create higher standards to drive scholastic improvement as a country (Tennessee Department of Education, 2013) and allow the United States to maintain global competitiveness (National Governers Association Center for Best Practices, Council of Chief State School Officers, 2008).

The shift “from ‘vertical’ production—where all tasks are done in sequence in the same place—to ‘horizontal’ production in which tasks are carved up and shipped out to wherever they can be done best and cheapest” (National Governers Association Center for Best Practices, Council of Chief State School Officers, 2008, p. 9) has christened a new era in education, an era exemplified by the CCSS. According to PBL and school redesign expert Thom Markham (2012), “Common Core Standards place more stress on projects, deep thinking, active learning, and performance-based instruction methods than previous state standards” (p. xv).

The National Governers Association Center for Best Practices and the Council of Chief State School Officers (2008) reported in, *Benchmarking for Success: Ensuring U.S. Students Receive A World Class Education*, “World-class content standards cover a smaller number of topics in greater depth at every grade level” (p. 24). The Tennessee Department of Education (2013) explained that “standards define learning expectations” (p. 1). The majority of teachers have echoed the sentiment that high expectations are needed for all students. In fact, according to a joint 2013 report from Achieve, College Summit, the National Association of Secondary School Principals (NASSP), and the National Association of Elementary School Principals (NAESP), 86% of teachers believe that setting high expectations for students will improve student achievement (p. 1).

The Tennessee Department of Education (2013) identified a few benefits of adopting the more rigorous CCSS in the following excerpt from, *The Common Core State Standards: History and Fact Sheet*:

> The Common Core State Standards are meant to provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy. (p. 3)

The CCSS were written at a higher level than current state standards. Thus, the writers have raised the expectations for students in Missouri (Missouri Department of Elementary and Secondary Education, 2013). The standards themselves have been evaluated to ensure they are rigorous and have a focus on higher order thinking skills (Missouri Department of Elementary and Secondary Education, 2013).

Following the train of thought that "we need students who are prepared to compete not only with their American peers, but with students from all across the globe for the jobs of tomorrow" (National Governers Association Center for Best Practices, Council of Chief State School Officers, 2008, p. 1), the CCSS have been "internationally benchmarked" (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010, para. 3). To benchmark the standards, the National Governors Association Center for Best Practices and Council of Chief State School Officers (2008) analyzed the practices of high achieving countries to determine best practices and standard benchmarks. Global competitiveness is more important than ever before, as "rulebound jobs on factory floors and in offices are being automated and outsourced" (National Governers Association Center for Best Practices, Council of Chief

State School Officers, 2008, p. 5). The United States has moved further into a "skills-driven global economy," which rewards economies focused on "knowledge fueled innovation" (National Governers Association Center for Best Practices, Council of Chief State School Officers, 2008, p. 9).

The framers of the CCSS wrote the standards with an intended focus on key skills, which colleges and businesses currently find lacking. "College and Career Ready" is defined as, "success – without remediation – in credit-bearing general education courses or a two-year certificate program" (Conley D. , 2010, p. 3). In the *Blueprint for Success*, the U.S. Department of Education (2010) outlined one of the major goals for education reform in the following statement:

> Others may see the goal of preparing every student for college or career as pie in the sky, but President Obama believes that education is a great equalizer. Skeptics say we must first solve our country's economic problems, but the president knows that we have to educate ourselves into economic security. (p. 11)

College readiness goes beyond mere college eligibility (Achieve, 2013). The fact that most high school graduates require remedial help in college, most college students leave college before attaining a degree, and an apparent lack of employable work skills (Tennessee Department of Education, 2013) play a large role in current reforms which focus "on more critical thinking and problem solving, which are the real world skills that students need to be successful in education beyond high school and in the workforce" (Expect More Achieve More Coalition, 2013, p. 1). The Missouri Department of Elementary and Secondary Education (2013) contended that having more rigorous standards would undoubtedly allow students to find greater success in college and beyond. The Achieve (2013) group, along with College Summit, NASSP, and NAESP, in their implementation action brief, identify that "the adoption of these [Common Core State] standards means that all, not just some, students should be on the pathway to college and career readiness" (p. 2).

It is important to note that rigorous standards are important. However, "college and career readiness is a multidimensional construct, and content knowledge is only one of several key dimensions" (Conley, Drummond, de Gonzalez, Rooseboom, & Stout, 2011, p. 99). Other dimensions including the behaviors and skills needed for success in college and career are addressed in the following section.

21st Century Workplace and Educational Philosophy

Public education has typically been "shaped by specific assumptions about labor markets, many of which are hopelessly out of date" (Robinson, 2011, p. 50). The United States has evolved out of an agricultural labor force wherein the requisite knowledge was that of "know-how" and required no formal education " (New Zealand Council for Educational Research, 2009, para. 5). The industrial revolution shifted the United States from that "know-how" system toward a new understanding where the requisite knowledge was more "know what" (New Zealand Council for Educational Research, 2009, para. 5).

Public education in the industrial age reflected the manufacturing assembly line nature of the industrial age workforce. Thus, schools were designed like factories, based on the "principles of standardization and conformity" (Robinson, 2011, p. 57). The New Zealand Council for Educational Research (2009) asserted that "this one-size-fits-all system works reasonably well as a way of sorting people into the different kinds of worker-citizens needed by Industrial Age societies" (para. 5).

The current model of public education was created as a means to meet the needs of a largely industrial 20th century economy (Robinson, 2011). However, authors and 21st century learning experts Trilling and Fadel (2009), identified the following shift which occurred as the United States transitioned from the 20th into the 21st century:

> In 1991, the total money spent on Industrial Age goods in the United States—things like engines and machines for agriculture, mining, construction, manufacturing, transportation, energy production, and so on—was exceeded for the first time in history by the amount spent on information and communications technologies: computers, servers, printers, software, phones, networking devices and systems, and the like. (p. 3)

Even though this shift occurred in 1991, as of 2014 public education still:

> ...operate[d] on an agrarian calendar (summers off to allow students to work in the fields), an industrial time clock (fifty-minute classroom periods marked by bells), and a list of curriculum subjects invented in the Middle Ages (language, math, science, and the arts). (Trilling & Fadel, 2009, p. 12).

However, two groups —the Partnership for 21st Century Skills and the ISTE —have worked diligently to influence public policy and move public education into the modern age.

Founded in 2002, the Partnership for 21st Century Skills (2014) has made it their mission to build "collaborative partnerships among education, business, community, and government leaders" ("Our Mission," para. 1). The Partnership for 21st Century Skills

(2009) has defined “the skills, knowledge and expertise students should master to succeed in work and life in the 21st century” by creating a framework for learning (p. 2). This framework was founded on the three Rs and the four Cs. The three Rs represent core academic content such as reading, writing, math, civics, history, etc, and the four Cs represent the swath of skills students need to be successful in college, career, and life (Partnership for 21st Century Skills, 2011). Furthermore, the Partnership for 21st Century Skills (2011) identified the 4 Cs as creativity and innovation, critical thinking and problem solving, collaboration, and communication. A discussion of related literature surrounding the four Cs can be found in the following sections..

Creativity and innovation. As the world traveled into the 21st century, a number of significant challenges came into view. Challenges, such as “overpopulation, overconsumption, increased global competition and interdependence, melting ice caps, financial meltdowns, and wars and other threats to security” (Trilling & Fadel, 2009, p. 6). As humanity faced some of the most daunting challenges in history, Robinson (2011), and expert on creativity, concluded, “our best resource is to cultivate our singular abilities of imagination, creativity and innovation” (p. 47). Robinson (2009) defined creativity as “the process of having original ideas that have value” (p. 67).

The United States needs a system of education focused on creative entrepreneurship (Zhao, 2012). Since the students of today will be responsible for solving the problems of tomorrow, “now is the perfect time for teachers to plan projects with students to help them make a contribution to the world” (Markham, 2012, p. xii). With routine work being automated or shipped to less developed countries, this new century brings with it an ever increasing demand for creative work in more developed countries (Trilling & Fadel, 2009). Schools need to follow suit and shift their focus from content consumption to content creation (Bender, 2012).

Critical thinking and problem solving. The ability to think critically to address and solve complex problems is an essential skill of an effective 21st century citizen (Marzano & Heflebower, 2012). A PBL expert, Markham (2012), clarified critical thinking as “a blend of attributes, including habits, attitudes, and emotional openness; thinking strategies; background knowledge; conceptual knowledge; and criteria for judgment. All of these can be learned-synergistically-through well-designed projects that challenge students to solve meaningful problems” (p. xi). Students need experiences which allow them to synthesize available information to solve the problems their generations will face (Bender, 2012).

Collaboration. An increasingly networked world has created a culture of collaboration and continuous social learning (Markham, 2012). Teachers using collaboration in the classroom require students to cooperate in groups on a collective learning activities (Barron & Darling-Hammond, 2008). The ISTE defined collaboration as a process of working together “to support individual learning and contribute to the learning of others” (ISTE, 2007, p. 1). This contribution to others leads to solving real world problems, which was an essential skill in the 21st century workplace (Trilling & Fadel, 2009).

Students in classrooms often find themselves in situations in which they are called to work with others (Bender, 2012). However, for collaboration to be truly considered effective, skills which are collaborative in nature must be intentionally taught (Hattie, 2012). The skills of group processing, individual accountability as a member of the team, interpersonal skills, conflict management strategies, decision-making strategies, and effective personal communication skills are just a few of the practices needing taught intentionally in the classroom (Bender, 2012).

The outcomes of strategic collaboration can cover a broad range. It can even be seen simply as a tool for dividing the project work equitably (Barron & Darling-Hammond, 2008; Boss, 2012; Thomas, 2000). These segments allow individual students to take control of a more manageable section of the workload. This can alleviate some of the natural stress which accompanies the solving of a large, open-ended and real world problem (Boss, 2012). Collaboration can also be seen on a deeper level as a way for students to develop empathy though active dialogue and discussion within their groups (d.school, 2010). Through this lens of collaboration, students are able to identify the individual merits and skillsets of the other members of their group and develop a group consensus (Boss & Krauss, 2007).

Collaboration is an incredibly important skill and is present in nearly all 21st century workplaces (Bender, 2012). The National Academy Foundation and Pearson Foundation (2011) went so far as to identify "teamwork" as an expected competency of "high-performance work organizations" (p. 19). Businesses called for a workforce capable of collaborating and working well with colleagues (Massachusetts Business Alliance for Education, 2006). Then, as the world became increasingly connected, communities became more and more networked, which caused a shift into what Markham (2012) called "a collaborative culture of continuous learning" (para. 10).

Communication. Modern communication is an interactive process of discernment and expression (Zhao, 2009). In an "age of instant communication. . . and availability of nearly unlimited information on the internet…making sense of the virtual mountain of chaotic information is exactly the type of knowledge construction that every student in today's world needs to master" (Bender, 2012, pp. 22-23). The innate curiosity of humans and desire to inquire is a process begun as early as infancy, when children begin to experiment with language (Barell, 2007). Through inquiry, students can learn the value of discernment by making careful observations, asking good questions, and carrying out relevant experimentation (Gardner, 2011).

Being able to effectively communicate with colleagues and the public is a skill referenced by many (Bender, 2012; Boss, 2012; ISTE, 2007; Marzano & Heflebower, 2012; Partnership for 21st Century Learning, 2009). According to a 2006 report from the Massachusetts Business Alliance for Education (MBAE), employers were in desperate need of entry-level applicants with the ability to effectively communicate both orally and in writing. This skill was so important that the MBAE (2006) proposed that high schools add mandatory public speaking courses to their curriculum.

The ISTE and the standardization of 21st century skills. Founded in 1979, the ISTE is an international association of educators and education leaders focused on the advancement of the teaching profession through the use of technology and advanced technical skills. The ISTE (2012) claimed stewardship of the "definitive education technology standards… [and a mission to] empower learners to thrive in a connected world" ("Our Mission," para. 5). The group created the ISTE Standards-S because of their belief that technology was ubiquitous and has altered the foundations of what students needed to learn as well as how they learn. The ISTE (2012) felt that educators required a "standard of excellence and best practices in learning, teaching and leading with technology in education" ("Standards," para. 4).

The original standards for students were released by the ISTE in 1998 after being developed for nearly three years (International Society for Technology in Education, 2012). However, the 1998 standards were focused on specifically what students needed to be able to know and do with technology (International Society for Technology in Education, 2007). By 2006, the ISTE realized that the landscape had changed. They felt it was no longer enough to just teach technology but skills as well and released an updated version of the Standards for Students the following year (International Society for Technology in Education, 2012). The 2007 ISTE Standards-S shifted the focus from technology tools to skills and expertise (ISTE, 2007). This shift to skills and expertise allowed for better alignment of the ISTE Standards-S with the 21st century skills outlined by the Partnership for 21st Century Skills (P21) Learning and Innovation Skills (see Table 1). It was determined that ISTE Standards-S would be an acceptable set of standards to assess 21st century skills.

Table 1

ISTE Standards-S Alignment to P21 Learning and Innovation Skills of 21st Century Learners

P21 Learning and Innovation Skills	ISTE Standards-S
Creativity and Innovation • Think Creatively • Work creatively with others • Implement Innovations	• Creativity and Innovation
Critical Thinking and Problem Solving • Reason Effectively • Use Systems Thinking • Make Judgments and Decisions • Solve Problems	• Critical Thinking, Problem Solving, and Decision Making • Technology Operations and Concepts
Collaboration • Collaborate with others	• Communication and Collaboration • Digital Citizenship
Communication • Communicate Clearly	• Communication and Collaboration • Research and Information Fluency

The Educational History of Project-based Learning

The pedagogical approach called PBL has gotten much attention during the time of enhanced standards and 21st century "college and career readiness" (Association for Supervision and Curriculum Development (ASCD), 2012; Boss, 2012; Markham, 2012; Zhao, 2012). However, PBL was rooted in educational philosophies which span the globe and go back to the days of Confucius, who famously said, "I hear and I forget. I see and I remember. I do and I understand" (Richards, 2007, p. 4).

The 17th century, Czech philosopher, John Comenius, who championed universal education as a means to reform society (College, 2014), also "questioned the effectiveness of memorization and recitation, emphasizing instead the need to base teaching on children's interests and needs” (Kauchak & Eggen, 2011, p. 33). The 17th century, English philosopher John Locke (1692) believed in the importance of firsthand experiences for effective student learning. In the 18th century, philosophers, such as Jean Jacues Rousseau of France and Johann Pestalozzi of Switzerland fought to provide students with more exploratory learning opportunities steeped in concrete experiences where students could utilize their playfulness and natural curiosity to learn (Kauchak & Eggen, 2011).

These philosophers laid the foundation for 20th century reformer, John Dewey (1916), who felt students needed genuine experiences to gain knowledge. These genuine experiences could also be used as an instrument to solve problem. Kilpatrick (1918) was the first to label this approach as the “project method” (p. 319).

While PBL was derived from the theories mentioned above, its first pedagogical implementation was developed by Howard Barrows in the 1960s. Barrows, an educator at McMaster University Medical School in Canada, was looking for an instructional approach which would allow students to explore problems and gain the knowledge to create solutions (Barrows, 1985). He had the realization that doctors gain the knowledge to solve a medical problem by actually experiencing that problem and developing the solution (Barrows, 1985). His theory was that the knowledge gained through those experiences would stick with his students well into their careers in the medical profession (Savery, 2006). Barrows (1985) focused on the need for medical professionals to “have both knowledge and the ability to use it” (p. 3).

Many studies on the effects of PBL have been conducted and analyzed since its inception. These investigations resulted in a variety of findings (Thomas, 2000). When compared side-by-side, students taught with the PBL approach scored at the same level on conventional tests of knowledge as those students taught using more conventional approaches (Savery, 2006). Marzano and Heflebower (2012) found "when assessments were performance or skill based or required a combination of knowledge and skill, students taught using PBL scored higher than students taught using more traditional methods of instruction" (p. 15). Other investigative reports identified gains for students in the areas of collaboration, professional skills and attitudes, and study habits (Ribiero, 2011). These studies also showed that given the choice of instructional strategy, students prefer being taught though the PBL method (Savery, 2006).

Even with the largely positive sentiment for PBL, there have been many educational professionals fearful of shifting to a PBL approach (Henry, 2012). Savin-Baden (2000) attributed a portion of the educator's fear to a lack of research on the impact of using the PBL approach on the daily lives of staff, students, and institutions. In a 2012 survey of United States school administrators, Tim Henry (2012), a frequent Edutopia contributor, found many barriers to implementation of PBL including "lack of time, curricular competition, assessment difficulties, lack of professional development, and challenges with classroom management… the largest stated barrier [being] lack of professional development" (para. 8). Thomas (2000) attributed the lack of professional development to the wide variety of individual PBL models. This issue can be addressed with a standardized PBL method. One such standardized approach is outlined in the following section.

The Standards of Project-based Learning

Incorporating PBL in the classroom could be used to help students prepare for the future (Zhao, 2012). However, due to the variety of nuanced models and misconceptions of PBL (Savery, 2006), combined with a lack of professional development opportunities (Henry, 2012), and an increase in accountability via standardized tests which only assess static scholastic performance, PBL was not typically a strategy teachers chose when developing lessons (Trilling & Fadel, 2009). The literature on the topic of PBL was extensive and varied. As Thomas (2000) found in his review of research on PBL, there was a "diversity of defining features coupled with the lack of a universally accepted model or theory of Project-Based Learning [which] has resulted in a great variety of PBL research and development activities" (p. 1).

To define a universally acceptable model of PBL, 10 expert sources written specifically on the topic of PBL were analyzed. All 10 sources varied slightly in their proposed approach to the implementation of PBL. However, six components which could be considered "common" or "essential" to PBL were identified. The common components and subsequent Standards of PBL can be found in Table 2. PBL, using the Standards of PBL from this study, can be defined as an instructional method in which students are guided to publicly present a tangible product which was collaboratively developed and refined to solve a real world issue.

Table 2

Standards of Project-based Learning (PBL)

Common PBL Component	Synthesized PBL Standard
1. Driving Question/ Problem Statement	PBL 1: Define or explain the driving question or problem to be solved.
2. Student Inquiry	PBL 2: Research topics related to the driving question or problem to be solved.
3. Effective Teamwork	PBL 3: Work collaboratively to generate possible solutions or courses of action.
4. Frequent Feedback/ Opportunities for Revision	PBL 4: With guidance and support from adults and peers, focus on a singular solution or course of action.
5. Tangible Product	PBL 5: With guidance and support from adults and peers, collaboratively produce a tangible product which addresses the driving question or problem to be solved.
6. Publicly Presented Product	PBL 6: Publicly unveil the product to an audience for review.

PBL 1: Define or explain the driving question or problem to be solved. The process of PBL begins by defining or explaining a driving question or by framing a problem to be solved (Barell, 2007; Barron & Darling-Hammond, 2008; Bender, 2012; Boss & Krauss, 2007; Larmer & Mergendoller, 2010; Markham, 2012; National Academy Foundation and Pearson Foundation, 2011; Patton, 2012). The authentic challenge which is at the heart of every project provides “a foundation that infuses the

project with meaning and purpose" (Markham, 2012, p. 7). This focus on meaning and purpose enhance student motivation to complete and present quality work. Expert on motivation, Daniel Pink (2005) believed "man's main concern is not to gain pleasure or to avoid pain but rather to see a meaning in his life" (p. 217). A problem scenario grounded in a real world issue attaches authentic meaning to each project, which has the power to enhance student motivation (Bender, 2012).

A collaboratively developed guiding question was referenced in nearly all models of PBL (Bender, 2012). Teachers used these questions to guide the students through the twists and turns of their project offering them "multiple solutions and methods for reaching them, rather than a single 'right' approach" (Barron & Darling-Hammond, 2008, p. 5). As Response to Intervention and PBL specialist Bender (2012) stated in his PBL field guide, *Project-based Learning: Differentiating Instruction for the 21st Century,* "An effective driving question summarizes the problem or issue, uses compelling language to motivate students, and points to supplementary or secondary questions that need to be addressed" (p. 66).

When he discussed student motivation as a means for quality instruction, instructional coach Jim Knight (2013) stated, "Work that is meaningful, interesting, personally relevant, and chosen by students is likely work that students will be motivated to complete" (p. 230). Howard Gardner (2011) determined that when an activity is meaningful and challenging, students "come to feel a genuine stake in the outcome of their (and their peers') efforts" (p. 216). Since "we are rarely motivated by others' goals" (Knight, 2013, p. 230), the process of crafting a driving question or defining a real world problem has the potential to intrinsically motivate students to do the work necessary to solve the problem.

Creating a solution to a real world problem often creates an authentic motivation within the students (Bender, 2012). This motivation is what drives students throughout the PBL process to work toward the completion of the task. Teachers cannot force students to become motivated because “motivation isn’t about compliance or control; it’s about choice” (Jackson, 2011, p. 18).

When teachers give students choice, they open the door for instruction grounded in the students’ passions. In her book, *Classroom Habitudes*, Angela Maiers (2012) defined passion as “the ability to intentionally pursue actions that are personally and socially meaningful” (p. 99). This level of motivation was most prevalent in projects “when students have a major voice in defining the project [and] identifying the driving question at the heart of the work” (Knight, 2013, p. 226). While each project taken on by students will be completely unique, nearly all projects created in the PBL method focus on authentic, real world issues (Bender, 2012).

PBL has been identified as the process of direct application of learned knowledge toward an identified problem (Vega, 2012). The results of this process and the solutions which are created often have implications beyond the confines of the classroom (Markham, 2012). For students to become effective citizens in the 21st century, they must be able to solve complex problems and issues (Marzano & Heflebower, 2012). Markham (2012) suggested that the driving question be both “meaningful and doable” (p. xiii). A meaningful and doable driving question allows students to hone their thoughts and narrow their focus to a more manageable level. This narrowed focus keeps students from veering away from the problem at hand (Bender, 2012).

PBL 2: Research topics related to the driving question or problem to be solved. The second standard of PBL involves students researching topics related to the driving question or problem to be solved. The "problem-solving process requires students to learn and use information to find a solution" (Markham, 2012, p. x). Once a question is developed or a problem identified, students are able to enter into a "learner-centered approach" (Savery, 2006, p. 12) which "involves [them] in a constructive investigation" (Thomas, 2000, p. 3). When a teacher asks students "to spend significant amounts of time doing field-based work" (National Academy Foundation and Pearson Foundation, 2011, p. 18) students are allowed to develop an ownership of the material that they are learning (Patton, 2012).

In order for PBL to be truly effective "students must have the responsibility for their own learning" (Savery, 2006, p. 12). Students in this student-driven process of inquiry are able to become responsible for the management of the collective workload (Barron & Darling-Hammond, 2008). This student-centered inquiry process was found to be as central to the PBL process as problem identification (Barell, 2007). Students in the PBL process are expected to ask questions and research topics related to the driving question or problem to be solved. At some point during this process of asking questions, seeking the answers, refining questions, and developing solutions, students are expected to begin developing the capacity to think critically (Barell, 2008).

During the student-driven inquiry process of PBL, students will most likely discover "situations characterized by doubt, difficulty, complexity, novelty, conflict, and mystery" (Barell, 2008, p. 20). These characterizations allow teachers utilizing this process to "engage the students' attention and energize their participation in the educational process" (November, 2012, p. 16). The instructional practices of exploration and investigation are propagated by the forces of curiosity (Barell, 2008). Curiosity is an innate characteristic of humans (Gray, 2013), and harnessing that curiosity for instructional purposes "engages students because they find the project interesting, meaningful, and personally relevant" (Knight, 2013, p. 227).

Pink (2009) identified autonomy as one of the three most important factors of motivation. Zhao (2012), Presidential Chair and Director of the Institute for Global and Online Education in the College of Education at the University of Oregon, felt that self-directed inquiry allows students to be autonomous in their learning. The autonomy created during the inquiry process typically leads to higher levels of student motivation and subsequent participation (Bender, 2012). The vested personal interest developed during the inquiry of a challenging project can lead students toward discovery of a personal passion which could last a lifetime (Boss, 2012).

PBL 3: Work collaboratively to generate possible solutions or courses of action. Solving real world problems in the 21st century workplace requires effective teamwork (Trilling & Fadel, 2009). The third identified common component of PBL involves effective teamwork amongst the students (Barell, 2007; Barron & Darling-Hammond, 2008; Bender, 2012; Boss & Krauss, 2007; Knight, 2013; Larmer & Mergendoller, 2010; Patton, 2012; Ravitz, 2009). Students will often find themselves in situations which call for them to collaborate or work with others (Bender, 2012). However, using the PBL approach can allow teachers to explicitly teach students to collaborate both "purposefully and respectfully" (Markham, 2012, p. xii). Effective teamwork was found to be the byproduct of intentionally teaching skills which are collaborative in nature (Hattie, 2012). These skills included group processing, individual accountability as a member of the team, interpersonal skills, conflict management strategies, decision-making strategies, and effective personal communication skills (Bender, 2012).

Within the confines of the different approaches to PBL, collaboration looks similar. However, there are slight differentiations to each description of collaboration and teamwork. For instance, some of the writers highlight collaboration as a tool for simply dividing the project work equitably (Barron & Darling-Hammond, 2008; Boss, 2012; Thomas, 2000). These writers asserted that collaboration is essential to the PBL approach due to the very nature of solving a large, open-ended and real world problem. Teamwork is said to offer students a way to break this task up into "manageable pieces" (Boss, 2012, p. 40).

Other sources referred to a more "radical" approach to collaboration. Stanford University's School of Design (d.school) (2010) defined "radical collaboration" as, "Cross disciplinary thinking and collaboration with those who have different skill sets and talents" (p. 3). This type of collaboration allows students to build empathy for their teammates which allowed them to break through misconceptions and work to develop a team consensus (Boss & Krauss, 2007).

Since the PBL instructional approach was designed for real world application of knowledge and skills (Zhao, 2012), to writers like Bender (2012), collaboration is the most important component of the PBL process that teachers can teach as it is "a critical workplace skill for virtually every 21st century job" (p. 52). The National Academy Foundation and Pearson Foundation (2011) identified "teamwork" as an expected competency of "high-performance work organizations" (p. 19). As the world became increasingly connected and communities became more and more networked, a shift occurred, which Markham (2012) called "a collaborative culture of continuous learning" (para. 10).

One thing was clear across all definitions of PBL, teamwork is not just a common component amongst the sources, it was essential to the success of teachers utilizing the PBL method (Barell, 2007; Barron & Darling-Hammond, 2008; Bender, 2012; Boss & Krauss, 2007; Larmer & Mergendoller, 2010; Markham, 2012; National Academy Foundation and Pearson Foundation, 2011; Patton, 2012). When students work in teams of variety and size, they seize control of their learning (Knight, 2013). When students have control and power over their learning, they have the potential to "contribute to the learning processes of the entire class and to learners around the world" (November, 2012, p. 15).

PBL 4: With guidance and support from adults and peers, students work to narrow their focus on a singular solution or course of action. In effective PBL environments, the teacher do not remain a passive observer of the process (Larmer & Mergendoller, 2010). They meet frequently with each student group and offer thoughtful feedback. This common component was addressed in standard three of PBL. PBL was built on the foundation of loosely structured questions or problems with the possibility of multiple solutions (Bender, 2012). Due to the loosely structured, open nature of PBL, the role of the teacher has changed from the sole distributor of knowledge to a facilitator of learning (Savery, 2006). The teacher works shoulder-to-shoulder with their students guiding them toward their next level of achievement (Markham, 2012). There are multiple opportunities for assessment and feedback throughout the entirety of the PBL process (Markham, 2012; National Academy Foundation and Pearson Foundation, 2011; Patton, 2012; Vega, 2012).

Formative feedback is the most frequently utilized form of on-going assessment in the PBL process (Bender, 2012). The frequent guidance and support from the teacher ensures that the project stays on-track, elicits accurate information, and is organized for success (November, 2012). Knight (2013) put it this way, “When students receive daily feedback on their progress, when they see clear evidence that they are progressing, they are much more confident that they can tackle the learning tasks they experience in school” (p. 57).

Teachers who utilize the instructional practice of PBL are focused on standard mastery. Pink (2009) defined mastery as “the desire to get better and better at something that matters” (p. 109). PBL was intentionally designed for students to receive frequent feedback and revise their work through the process of multiple drafts before their final presentation (Barron & Darling-Hammond, 2008; Larmer & Mergendoller, 2010; Markham, 2012; Patton, 2012; Savery, 2006; Vega, 2012). One of the most effective ways to enhance and encourage innovation was found to be reducing the fear of failure (Kuyatt, 2011). When the feedback cycle is implemented successfully, teachers are able to change the very meaning of failure and reframe it as iteration (Vallon, 2013).

The d.school (2010) at Stanford University built a “culture of prototyping,” which utilized a “fail fast” method of revision (p. 3). This method encouraged students to quickly produce prototypes of their designs and present them for critique. Each of these failure and feedback sessions taught the group something new about their design which allowed them to find better ways to achieve a high quality final product (Larmer & Mergendoller, 2010; Savery, 2006). In reference to a Carol Dweck study on mindsets of growth, Pink (2009) found that the young people in the study with a growth mindset "recognized that setbacks were inevitable on the road to mastery and that they could even be guideposts for the journey" (p. 121).

This transformative approach can most readily be seen in the game-based play of children (Gray, 2013). The ELA CCSS cited "play" as a viable instructional strategy for teaching important skills such as grit and curiosity as a means for mastery of the CCSS (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). When students feel they are playing, they were found to be more apt to take risks and refine their process to achieve their target (Trilling & Fadel, 2009). Students engaged in the PBL process develop an understanding of "how they learn and how to improve their performance" (Barron & Darling-Hammond, 2008, p. 4). If a teacher is able to package instruction as play, students are more willing to take the risks necessary to achieve their target (Gray, 2013). The ability to persist and persevere to the end of the project is identified as a hallmark of the PBL approach (Boss, 2012).

PBL 5: With guidance and support from adults and peers, students must collaboratively produce a tangible product which addresses the driving question or problem to be solved. Another one of the most commonly cited components of PBL across the literature is the creation of a culminating product (Barell, 2007; Barron & Darling-Hammond, 2008; Bender, 2012; Boss & Krauss, 2007; Larmer & Mergendoller, 2010; Markham, 2012; National Academy Foundation and Pearson Foundation, 2011; Patton, 2012). The possible products vary from something explanatory, like an informational short film or public service announcement, to something more prototypical, like an airplane design which solves an efficiency problem within the aero design industry (Markham, 2012; Patton, 2012). While there may be some flexibility as to the specific nature of the product, the consensus throughout the reviewed literature is that the products must have value within the extended community (Markham, 2012).

Students create effective products to "make relevant contributions to the community in which they live" (Gardner, 2011, p. 208). Designing and producing relevant products that have merit in one's community has the ability to bolster student ownership of their learning which in turn raised student motivation (November, 2012). When students shift from the design process and enter the developing process they are able to hone their abilities to be more creative and innovative (d.school, 2010; Trilling & Fadel, 2009; Zhao, 2012). This powerful component of the PBL approach allows students the means to become the creative agents of change in the 21st century (Bender, 2012).

PBL 6: Publicly unveil the product to an audience for review. The PBL approach culminated in the public unveiling of the created tangible product to an audience for review (Barell, 2007; Barron & Darling-Hammond, 2008; Bender, 2012; National Academy Foundation and Pearson Foundation, 2011). The presentation of the product or materials takes many forms and are as varied as the imaginations of the teachers and students involved in the project (Bender, 2012). Bender (2012) believed this component of PBL to be of particular importance as "students value this aspect of PBL more so than any other" (p. 71). The entire PBL process is centered on the idea that what students do in their project is reflective of what they will encounter in the world outside of school (Bender, 2012; Patton, 2012).

Standard six of PBL exemplifies the purpose of the PBL process. This standard signals to all involved that what they did, and the solution they developed, mattered and had value (Markham, 2012). The ability to make a meaningful contribution to the worldwide community is "essential to survive and thrive in the age of meaning" (Maiers, 2012, p. 99). The authentic work done in the PBL process indicates to the students that their time is well spent, and thus "relevant, interesting, and important" (Knight, 2013, p. 226).

Through PBL, students share their perspectives and solutions with a worldwide audience, which provides "an even greater motivator to do good work than would any grade they might have received" (November, 2012, p. 26). When determining how to assess the quality of a project-based assignment, teachers use "real-world criteria" (Knight, 2013, p. 227). Gardner (2011) called this the "test of the street," which is in reference to testing a bicycle's ability to operate on the street (p. 216).

Project-based Learning Used as a 21st Century Teaching Strategy.

The purpose of this study was to determine if the cognitive processing potential of PBL was high enough to meet the cognitive processing demands of the CCSS and the ISTE Standards-S. Through the review of literature on PBL and 21st century skills, it was discovered that an alignment of the synthesized Standards of PBL with the skills outlined by P21 was needed. This alignment allows educators to determine whether PBL is a viable 21st century teaching strategy.

When compared to the Partnership of 21st Century Skills four Cs of 21st century learning, multiple PBL standards fell under each category. For instance, PBL 3, 5, and 6 all fell within the defined parameters of the creativity and innovation category of skills. Some of the Standards of PBL fell within the defined parameters of multiple 21st century skills (Partnership for 21st Century Skills, 2011). PBL 3, for instance, encompassed skills from each of the four Cs (see Table 3).

Table 3

Standards of PBL Alignment to P21 Learning and Innovation Skills of 21st Century Learners

P21 Learning and Innovation Skills	Standards of PBL
Creativity and Innovation • Think Creatively • Work creatively with others • Implement Innovations	**PBL 3**. Work collaboratively to generate possible solutions or courses of action. **PBL 5**. With guidance and support from adults and peers, collaboratively produce a tangible product which addresses the driving question or problem to be solved. **PBL 6**. Publicly unveil the product to an audience for review.
Critical Thinking and Problem Solving • Reason Effectively • Use Systems Thinking • Make Judgments and Decisions • Solve Problems	**PBL 1**. Define or explain the driving question or problem to be solved **PBL 2**. Research topics related to the driving question or problem to be solved. **PBL 3**. Work collaboratively to generate possible solutions or courses of action. **PBL 4**. With guidance and support from adults and peers, focus on a singular solution or course of action.
Collaboration • Collaborate with others	**PBL 3**. Work collaboratively to generate possible solutions or courses of action. **PBL 4**. With guidance and support from adults and peers, focus on a singular solution or course of action. **PBL 5**. With guidance and support from adults and peers, collaboratively produce a tangible product which addresses the driving question or problem to be solved.
Communication • Communicate Clearly	**PBL 3**. Work collaboratively to generate possible solutions or courses of action. **PBL 6**. Publicly unveil the product to an audience for review.

Summary of Research Findings

Implementation of the CCSS is a challenging prospect for educators and is less about “thinking out of the box… [and more] about transforming the box itself” (Achieve, 2013, p. 4). In Chapter Two, this challenge was explored through an analysis of the research conducted in each broad category of the review. Through these analyses, the most integral components of each topic were identified. From the research, six components were identified as being common to all forms of PBL.

In Chapter Three, there is a discussion on the methodology used for comparing the cognitive verbs of those PBL components to the cognitive verbs of the CCSS. This comparison will determine whether PBL is able to meet the cognitive rigor of the CCSS. This understanding will allow for professional development coordinators, administrators, and teachers to identify the specific areas that would enhance teachers’ knowledge of PBL.

Chapter Three: Methodology

Introduction

The purpose of this study was to analyze and compare the cognitive processing language of the Common Core State Standards (CCSS), the International Society for Technology in Education Standards for Students (ISTE Standards-S), and the standards of Project-based Learning (PBL). By quantifying the language used in each set of standards using the revised Bloom's Taxonomy, the potential for teachers using the PBL method to meet the level of rigor required of the CCSS and the ISTE Standards-S could be determined. The CCSS represented the standards of instruction that teachers in Missouri were required to meet. ISTE Standards-S represented the 21st century skills which have been frequently cited as lacking in public education (Gray, 2013; Robinson, 2009; Tough, 2012; Zhao, 2009). The findings of this study could help teachers who have been looking for effective strategies for teaching 21st century skills in states which have adopted the CCSS.

A quantitative content analysis method was used to determine the ability of teachers using PBL to meet the rigor requirements of the CCSS. The U.S. General Accounting Office (1996) defined quantitative content analysis as "a methodology for structuring and analyzing written material" (U.S. General Accounting Office (p. 2). Quantitative content analysis can be used in any context in which the researcher desires a means of systemizing and quantifying data (Fraenkel &Wallen, 2009).

This was the same method for quantitative content analysis utilized by doctoral candidate Gallia (2012), that was based on a summary model put Fourth by Rourke and Anderson (2004), which stated content analysis is "a process that includes segmenting communication content into units, assigning each unit to a category, and providing tallies for each category" (p. 5). Gallia (2012) referenced this definition when she laid out her research design as the following:

> The researcher "segment[ed]" (Rourke & Anderson, 2004. p. 5) words from the Missouri GLEs and the CCSS, "assigned. . . a category" (Rourke & Anderson, 2004, p. 5) based on the revised Bloom's Taxonomy (Anderson & Krathwohl, 2001), and measured for a difference in means of each grade level in the areas of ELA and MA. The researcher also analyzed corresponding CCSS and MO GLEs for each grade level in the areas of ELA and MA to determine the strength of the overall relationship between each cognitive level per grade level of both documents with a Pearson product moment correlation coefficient (PPMC). (p. 65)

Through quantitative content analysis, an examination was conducted of the kindergarten through fifth grade CCSS in both English Language Arts (ELA) and Math (MA) (National Governers Association Center for Best Practices, 2010), as well as the ISTE Standards-S (ISTE, 2007) using the revised Bloom's "Cognitive Processes Dimensions" (Anderson & Krathwohl, 2001, pp. 67-68) as a guide for quantification of the standards. The cognitive process levels of each of the standards were compared with the cognitive process levels of the Standards of PBL, which were synthesized in Chapter Two of this project. This comparison allowed for the determination of the potential ability of each standard of PBL when used by teachers in the classroom to meet the cognitive processing demands of each of the CCSS and ISTE Standards-S.

The following questions guided this study:

1. Do the potential cognitive processing levels of the Standards of PBL meet or exceed the cognitive processing demands of a majority of the CCSS in grades K-5?
2. What is the difference in the mean cognitive processing levels of the CCSS and the Standards of PBL in grades K-5?
3. Do the potential cognitive processing levels of the Standards of PBL meet or exceed the cognitive processing demands of a majority of the ELA CCSS in grades K-5?
4. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL in grades K-5?
    a. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the kindergarten grade level?
    b. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the 1^{st} grade level?
    c. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the 2^{nd} grade level?
    d. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the 3^{rd} grade level?
    e. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the 4^{th} grade level?
    f. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the 5^{th} grade level?

5. Do the potential cognitive processing levels of the Standards of PBL meet or exceed the cognitive processing demands of a majority of the MA CCSS in grades K-5?
6. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL in grades K-5?
    a. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the kindergarten grade level?
    b. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the 1^{st} grade level?
    c. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the 2^{nd} grade level?
    d. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the 3^{rd} grade level?
    e. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the 4^{th} grade level?
    f. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the 5^{th} grade level?
7. Do the potential cognitive processing levels of the Standards of PBL meet or exceed the cognitive processing demands of a majority of the ISTE Standards-S?
8. What is the difference in the mean cognitive processing levels of the ISTE Standards-S and the Standards of PBL?

Research Design

The "Cognitive Process Dimensions" list from the revised Bloom's taxonomy (Anderson & Krathwohl, 2001, pp. 67-68) was used to assign cognitive values to the integral action verbs of each of the CCSS (National Governers Association Center for Best Practices, 2010), ISTE Standards-S (ISTE, 2013), and standards for each PBL component. The cognitive values were then compared. This comparison was used to determine whether the PBL component met the rigor of each particular standard for each subject at each grade level.

A single factor analysis of variance was then conducted for each grade level in each content area. These analyses allowed for a comparison of the mean cognitive processing levels of each set of standards to determine if there was a statistically significant difference in the level of cognitive processing language used in each set of standards (Bluman, 2013). Once this correlation was determined, the percentage of standards at each grade level which had the potential to be met with each standard of PBL, as well as any statistically significant difference in means between the CCSS, the ISTE Standards-S, and the Standards of PBL was reported.

Data Collection and Analysis Procedures

This was a quantitative content analysis focused on a comparison of the cognitive processing levels of the CCSS (National Governers Association Center for Best Practices, 2010), ISTE Standards-S – which focus on key concepts of digital age learning (ISTE, 2007) – and the synthesized Standards of PBL. These three items were analyzed for specific reasons which have been outlined in the following sections.

The CCSS, which were accessed on-line, have been adopted by “Forty-five states, the District of Columbia, four territories, and the Department of Defense Education Activity have adopted the Common Core State Standards” (National Governers Association Center for Best Practices, Council of Chief State School Officers, 2013, para. 1), including Missouri. The CCSS were chosen for analysis for the following reasons: the standards describe what students should be able to know and do at each grade level (National Governers Association Center for Best Practices, 2010), the adoption of the standards was a hotly debated topic in Missouri (Shuls, 2013), and Missouri had plans to tie the standards to state assessments and teacher evaluations (Missouri Department of Elementary and Secondary Education, 2012).

When asked how the CCSS compared to previous state standards, the National Governers Association Center for Best Practices and the Council for Chief State School Offices (2010) stated, “The standards are evidence-based, aligned with college and work expectations, include rigorous content and skills, and are informed by other top performing countries” (para. 7). Certain criteria, including “scholarly research” and “surveys on what skills are required of students entering college and workforce training programs”, used when creating the CCSS were also identified (National Governers Association Center for Best Practices and the Council for Chief State School Offices, 2010, para. 11).

As the CCSS reference 21st century skills as a necessary supplement to the CCSS, the ISTE Standards-S, accessed on-line were also selected for analysis. The ISTE Standards-S represent the standardized collection of 21st century “skills and knowledge students need to learn effectively and live productively in an increasingly global and digital world," and were written to "set a standard of excellence and best practices in learning, teaching and leading with technology in education" (ISTE, 2007, p. 1).

According to the National Governers Association and Council of Chief State School Officers (2010), "The [Common Core State] standards establish what students need to learn, but they do not dictate how teachers should teach" (para. 6). Teachers are still responsible for developing and implementing best practice teaching strategies to utilize in the classroom to ensure that their students meet the demands of the standards (Missouri Department of Elementary and Secondary Education, 2013). Due to this imperative, an instructional approach needed to be analyzed to see if it proved rigorous enough to meet the expected outcomes of the CCSS as well as the expected outcomes of the ISTE Standard-S.

Many instructional approaches have been proposed to teachers to meet these standards, however PBL was selected because the method is steeped in 21st century skills (Bender, 2012; Boss & Krauss, 2007; Vega, 2012) and because research shows PBL to have had a positive effect on student achievement (Knight, 2013; Ravitz, 2009; Thomas, 2000). Randi Weingarten (2013), the president of the American Federation of Teachers (AFT) has even weighed in via an AFT Press Release saying that educators should "focus on an enriching curriculum and project-based learning opportunities, and put an end to the testing fixation. Let's focus on a real implementation plan to make sure the Common Core lives up to its potential" (para. 5). The Standards of PBL were synthesized from 10 expert resources on the subject (see Table 4).

Table 4

Standards of PBL Cognitive Processing Levels

PBL Standard Number	Common Component	PBL Standard	Action Verb	Bloom's Synonym	Bloom's Sub-Level	Cognitive Processing Level
PBL 1	Driving Question/ Problem Statement	Define or explain the driving question or problem to be solved	Explain	Interpret	Define	2.1
PBL 2	Student Inquiry	Research topics related to the driving question or problem to be solved.	Research	Evaluate	Check	5.1
PBL 3	Effective Teamwork	Work collaboratively to generate possible solutions or courses of action.	Generate	Create	Generate	6.1
PBL 4	Frequent Feedback/ Opportunities for Revision	With guidance and support from adults and peers, focus on a singular solution or course of action.	Focus	Analyze	Focus	4.1
PBL 5	Tangible Product	With guidance and support from adults and peers, collaboratively produce a tangible product which addresses the driving question or problem to be solved.	Produce	Create	Produce	6.3
PBL 6	Public Presentation	Publicly unveil the product to an audience for review.	Unveil	Create	Produce	6.3

Gallia's (2012) "Cognitive Categories and Language" list (p. 164) as well as her "Synonyms List" (pp. 165-169) were used to quantify the action verbs in each of the standards according to their level of cognitive processing based on the language used in the revised Bloom's taxonomy (Anderson & Krathwohl, 2001). The levels of cognitive processing potential for each of the Standards of PBL were determined using the same tools. The goal of this quantitative analysis was to identify the percentage of CCSS at each grade level which can potentially be addressed through the various Standards of PBL.

The comparison of the cognitive processing values was used to determine whether the Standards of PBL are able to meet the cognitive demands of each individual CCSS. Once this determination was made, the percentage of CCSS at each grade level, which can be met by each standard of PBL, was reported and discussed. A series of single factor ANOVAs were run to determine the existence of a difference in the overall cognitive processing level as measured by the quantified language of the revised Bloom's Taxonomy.

Once the ANOVAs were run, if a difference was found, a Tukey test was run on the ANOVA findings to determine where the differences were and if they were statistically significant. The findings were then disaggregated and reported by subject and grade level in both ELA and MA. The same analysis was then conducted with the ISTE Standards-S to determine if the Standards of PBL have the potential cognitive processing power to meet the cognitive processing demands of those standards.

Participants

Only secondary data were utilized in this study; no human participants were involved. Once the research was completed and reviewed, the findings and conclusions of this study were available to the public. The standards and indicators used in this research were open to the public and freely accessible .

Conclusion

This chapter discussed the methodology used throughout this study. The documents selected and rationale for choosing each document were also identified. The standards were quantified using the tools developed by Gallia (2012), which were adapted from Anderson and Krathwohl's (2001) revision of Bloom's Taxonomy. Once the action verbs of the three sets of standards were quantified, comparative analyses were conducted to determine how many standards could potentially be met by using the PBL method. Finally, single factor analyses of variance were run to determine if a difference existed in the cognitive processing language of each set of standards. If a difference existed, a Tukey test was run to determine the location of the difference and the significance. The results of the study are discussed in Chapter Four.

Chapter Four: Results

Introduction

This quantitative analysis was conducted to determine the potential of the Standards of PBL to meet the cognitive processing levels of the CCSS (National Governers Association Center for Best Practices, 2010) and ISTE Standards-S (ISTE, 2007). The cognitive processing levels were quantified using the language of the revised Bloom's "Cognitive Processes Dimensions" (Anderson & Krathwohl, 2001, pp. 67-68) and Gallia's (2012) "Synonyms' List" (pp. 165-169). The study further investigated the relationship between the cognitive levels of the Standards of PBL, ISTE Standard-S, and the CCSS in ELA and MA grades K-5 to determine if there is a statistically significant difference in cognitive processing language between the sets of standards.

Treatment of the Data

As discussed in Chapter Three, the language of the revised Bloom's Taxonomy, (Anderson & Krathwohl, 2001) along with Gallia's (2012) Synonyms Lists, which can be found in Appendices A and B in her research study, were used to quantify the standards. The results included comparisons of the quantified levels of each set of standards. The results also included the findings of single factor analyses of variances, which were run to determine whether there were differences in the levels of cognitive processing between the sets of standards. Where differences were identified, Tukey tests were run to determine the significance of each difference.

Results and Analysis

Research Question 1. Do the potential cognitive processing levels of the Standards of PBL meet or exceed the cognitive processing demands of a majority of the CCSS in grades K-5?

According to the quantitative analysis of the CCSS, in grades K-5 and the standards for PBL, as measured by a comparison of quantified language defined by the revised Bloom's taxonomy (Anderson & Krathwohl, 2001; Gallia, 2012), it was surmised that using a combination of all six Standards of PBL as an instructional strategy has the potential to meet the cognitive processing levels of 100% of the CCSS.

On average, each standard of PBL has the potential to reach the cognitive processing level of 86.40% of the CCSS in grades K-5. PBL standards two through six met the cognitive processing levels of at least 88.66% of the CCSS at each grade level. PBL standard one, however, was only able to meet the cognitive rigor of an average 36.90% of the CCSS across the grade levels. In fact, standard one, when used as an isolated instructional strategy, was shown to be most effective in kindergarten where it has the potential to meet the cognitive processing level of 56.70% of the kindergarten CCSS. It decreases to its lowest point of effectiveness in the fourth grade where the potential cognitive processing level met or exceeded only 21.31% of the CCSS. The CCSS met by each standard of PBL can be seen in Table 5.

Table 5

CCSS Met or Exceeded by the Standards of PBL

Content	Grade	PBL 1	PBL 2	PBL 3	PBL 4	PBL 5	PBL 6	AVG
MA	K	11	24	24	20	25	25	21.50
ELA	K	44	70	70	66	72	72	65.67
Total Met		55	94	94	86	97	97	87.17
Percent Met		56.70%	96.91%	96.91%	88.66%	100.00%	100.00%	89.86%
MA	1	5	21	21	20	21	21	18.17
ELA	1	44	79	79	77	81	81	73.50
Total Met		49	100	100	97	102	102	91.67
Percent Met		48.04%	98.04%	98.04%	95.10%	100.00%	100.00%	89.87%
MA	2	7	25	26	24	26	26	22.33
ELA	2	37	69	69	67	71	71	64.00
Total Met		44	94	95	91	97	97	86.33
Percent Met		45.36%	96.91%	97.94%	93.81%	100.00%	100.00%	89.00%
MA	3	11	35	35	33	35	35	30.67
ELA	3	34	85	85	80	90	90	77.33
Total Met		45	120	120	113	125	125	108.00
Percent Met		36.00%	96.00%	96.00%	90.40%	100.00%	100.00%	86.40%
MA	4	5	35	35	30	35	35	29.17
ELA	4	21	81	83	72	87	87	71.83
Total Met		26	116	118	102	122	122	101.00
Percent Met		21.31%	95.08%	96.72%	83.61%	100.00%	100.00%	82.79%
MA	5	7	33	33	31	36	36	29.33
ELA	5	19	80	80	72	85	85	70.17
Total Met		26	113	113	103	121	121	99.50
Percent Met		21.49%	93.39%	93.39%	85.12%	100.00%	100.00%	82.23%
Total Met	ALL	245	637	640	592	664	664	573.67
Percent Met	ALL	36.90%	95.93%	96.39%	89.16%	100.00%	100.00%	86.40%

An analysis of the cognitive processing levels of the CCSS by grade level revealed some explanation for this outcome (see Table 7). PBL standard one to “define or explain the driving question or problem to be solved”, had a cognitive processing value of 2.1 (see Table 6). This value was the lowest value in the second level (understand) of the revised Bloom’s Taxonomy. This means this particular standard of PBL offers only enough cognitive processing potential to slightly exceed the cognitive processing demands of the lowest level of Bloom’s taxonomy (remember) and only includes 14.16% of the total CCSS for ELA and MA in grades K-5 when quantified using Gallia's (2012) framework for assigning cognitive processing levels to standards.

Table 6

Standards of PBL Cognitive Processing Levels

PBL Number	Common Component	PBL Standard	Action Verb	Bloom's Synonym	Bloom's Sub-Level	Cognitive Processing Level
PBL 1	Driving Question/ Problem Statement	Define or explain the driving question or problem to be solved.	Explain	Interpret	Define	2.1
PBL 2	Student Inquiry	Research topics related to the driving question or problem to be solved.	Research	Evaluate	Check	5.1
PBL 3	Effective Teamwork	Work collaboratively to generate possible solutions or courses of action.	Generate	Create	Generate	6.1
PBL 4	Frequent Feedback/ Opportunities for Revision	With guidance and support from adults and peers, focus on a singular solution or course of action.	Focus	Analyze	Focus	4.1
PBL 5	Tangible Product	With guidance and support from adults and peers, collaboratively produce a tangible product which addresses the driving question or problem to be solved.	Produce	Create	Produce	6.3
PBL 6	Public Presentation	Publicly unveil the product to an audience for review.	Unveil	Create	Produce	6.3

Table 7 shows that the percentage of CCSS at the "remember" level was at its peak in kindergarten where 21.65% of the 97 standards were at this level. However, the trend line for the CCSS written at the "remember" level hit its lowest point in fourth grade with only 7.38% of the standards written at this level. In the K-5 CCSS, there are 664 unique standards. Of the 664 standards, only 94 are written at the "remember" level. That is 14.16% of all K-5 CCSS. Twenty-one of the 94 "remember" standards are in kindergarten, compared to only nine in fourth grade and 11 in fifth grade. This breakdown of the CCSS by the revised Bloom's Taxonomy Level can be seen in Figure 1.

Table 7

CCSS at Each Level of Bloom's Taxonomy

Content	Grade	Remember	Understand	Apply	Analyze	Evaluate	Create	TTL
MA	K	1	15	2	5	1	1	25
ELA	K	20	32	13	3	2	2	72
Total		21	47	15	8	3	3	97
Percent		21.65%	48.45%	15.46%	8.25%	3.09%	3.09%	100.00%
MA	1	3	12	4	2	0	0	21
ELA	1	14	36	21	7	1	2	81
Total		17	48	25	9	1	2	102
Percent		16.67%	47.06%	24.51%	8.82%	0.98%	1.96%	100.00%
MA	2	2	11	11	1	0	1	26
ELA	2	16	34	15	3	1	2	71
Total		18	45	26	4	1	3	97
Percent		18.56%	46.39%	26.80%	4.12%	1.03%	3.09%	100.00%
MA	3	5	20	8	2	0	0	35
ELA	3	13	38	27	4	3	5	90
Total		18	58	35	6	3	5	125
Percent		14.40%	46.40%	28.00%	4.80%	2.40%	4.00%	100.00%
MA	4	3	17	9	6	0	0	35
ELA	4	6	38	26	10	3	4	87
Total		9	55	35	16	3	4	122
Percent		7.38%	45.08%	28.69%	13.11%	2.46%	3.28%	100.00%
MA	5	4	15	12	2	0	3	36
ELA	5	7	37	28	5	3	5	85
Total		11	52	40	7	3	8	121
Percent		9.09%	42.98%	33.06%	5.79%	2.48%	6.61%	100.00%
Total	ALL	94	305	176	50	14	25	664
Percent	ALL	14.16%	45.93%	26.51%	7.53%	2.11%	3.77%	100.00%

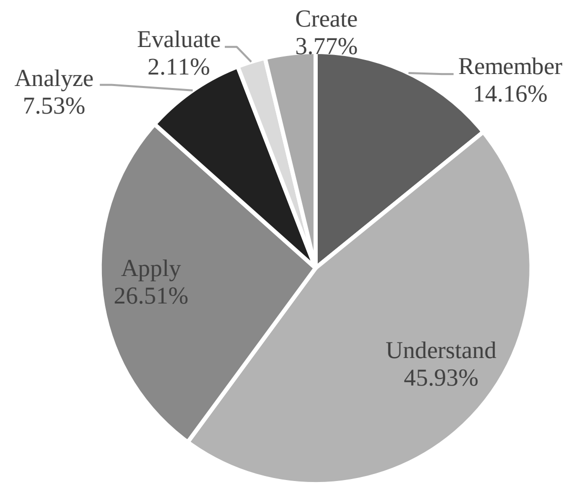

Figure 1. Percentage of CCSS at Each Level of the Revised Bloom's Taxonomy.

At the other end of the cognitive processing spectrum, PBL standards five – with guidance and support from adults and peers, collaboratively produce a tangible product which addresses the driving question or problem to be solved – and six – publicly unveil the product to an audience for review – were shown to meet or exceed the cognitive processing demands of 100% of the CCSS at each grade level. Both of these PBL standards were in the "create" level of Bloom's taxonomy and are both in the "produce" sub-level of "create."

According to the quantified levels of the revised Bloom's taxonomy, the potential cognitive processing level assigned to these standards is 6.3. This is the highest level of cognitive processing available as measured by the numerically-scaled comparison defined by the revised Bloom's taxonomy. This means these two standards, when used as instructional strategies in the classroom, have the potential to meet or exceed the cognitive processing levels of 100% of the ELA CCSS at every grade level K-5.

Each standard of PBL meets or exceeds an average of 86.4% of the standards at any given grade level when used as individual instructional strategies. However, when the Standards of PBL are utilized in conjunction with one another, PBL has the potential to meet or exceed the cognitive rigor requirements of 100% of the K-5 CCSS.

Research Question 2. What is the difference in the mean cognitive processing levels of the CCSS and the Standards of PBL in grades K-5? A single factor ANOVA was used to test for differences between the cognitive processing levels of the Standards of PBL and the cognitive processing levels of the K-5 CCSS (see Table 8).

Table 8

K-5 CCSS: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	31.27	1.00	31.27	23.85	0.00	3.86
Within Groups	875.91	668.00	1.31			
Total	907.19	669.00				

An alpha level of .05 was used in this analysis which resulted in a significance level of 95%. The single factor ANOVA revealed a difference in cognitive processing levels between the two sets of standards, F (1, 668) = 23.85122, p = 0.000. Tukey post-hoc comparisons of both sets of standards indicated that the cognitive processing levels of the Standards of PBL (M = 5, 95% *CI* [3.26, 6.745]) were significantly higher than the cognitive processing levels of the K-5 CCSS (M = 2.707, 95% *CI* [2.620, 2.794]).

The alpha level was set at .05 which revealed the critical level for Tukey's "Honestly Significant Difference" to be .123805. The difference was found to be statistically significant at 2.293373 (see Table 9). Therefore the null hypothesis was rejected. There was statistically significant evidence to support the claim there is a measurable difference in the cognitive processing levels of the fifth grade ELA CCSS and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy.

Table 9

K-5 CCSS Post Hoc Tukey Test

Groups	Count	Sum	Average	Variance
K-5 CCSS	664.00	1797.20	2.71	1.30
PBL	6.00	30.00	5.00	2.76
α	0.05			
HSD	.12			
Mean Difference	2.29			

Research Question 3. Do the potential cognitive processing levels of the Standards of PBL meet or exceed the cognitive processing demands of a majority of the ELA CCSS in grades K-5?

According to the quantitative analysis of the ELA CCSS in grades K-5 and the standards for PBL, as measured by a numerically-scaled comparison to the language defined by the revised Bloom's taxonomy (Anderson & Krathwohl, 2001; Gallia, 2012), it was surmised that using a combination of all six Standards of PBL as an instructional strategy has the potential to meet the cognitive rigor level of 100% of the ELA CCSS.

On average, each standard of PBL can potentially reach the cognitive processing level of 87.19% of the ELA CCSS in grades K-5. PBL standards two through six each met the cognitive rigor of nearly 90% of the ELA CCSS at each grade level. PBL standard one, however, was only able to meet the cognitive rigor of an average 41.97% of the ELA CCSS across the grade levels. In fact, standard one, when used as an isolated instructional strategy, was shown to be most effective in kindergarten where it has the potential to meet the cognitive processing level of 61.11% of the kindergarten ELA CCSS. That percentage fell consistently as the grade levels increased. It reaches its lowest point of effectiveness in the fifth grade, where the potential cognitive processing level met or exceeded only 22.35% of the ELA CCSS. The ELA CCSS met by each standard of PBL can be seen in Table 10.

Table 10

Percentage of ELA CCSS Met by Each PBL Standard, Grades K-5

PBL Standard	K	1st	2nd	3rd	4th	5th	Average
PBL 1	61.11%	54.32%	52.11%	37.78%	24.14%	22.35%	41.97%
PBL 2	97.22%	97.53%	97.18%	94.44%	93.10%	94.12%	95.60%
PBL 3	97.22%	97.53%	97.18%	94.44%	95.40%	94.12%	95.98%
PBL 4	91.67%	95.06%	94.37%	88.89%	82.76%	84.71%	89.57%
PBL 5	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
PBL 6	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
AVERAGE	91.20%	90.74%	90.14%	85.93%	82.57%	82.55%	87.19%

An analysis of the cognitive processing levels of the ELA CCSS by grade level revealed some explanation for this outcome (see Table 11). PBL standard one – define or explain the driving question or problem to be solved – had a cognitive processing value of 2.1. This value was the lowest value in the second level of the revised Bloom's Taxonomy (understand). This means this particular standard of PBL offers only enough cognitive processing potential to slightly exceed the cognitive processing demands of the lowest level of Bloom's taxonomy (remember).

Table 11 shows that the percentage of ELA CCSS at the "remember" level was at its peak in kindergarten where 27.78% of the standards were at this level. The trend line for the ELA CCSS written at the "remember" level reached the lowest point in fourth grade where only 6.90% of the standards were at this level.

Table 11

Percentage of ELA CCSS at Each Level of Bloom's Revised Taxonomy

	K	1st	2nd	3rd	4th	5th
REMEMBER	27.78%	17.28%	22.54%	14.44%	6.90%	8.24%
UNDERSTAND	44.44%	44.44%	47.89%	42.22%	43.68%	43.53%
APPLY	18.06%	25.93%	21.13%	30.00%	29.89%	32.94%
ANALYZE	4.17%	8.64%	4.23%	4.44%	11.49%	5.88%
EVALUATE	2.78%	1.23%	1.41%	3.33%	3.45%	3.53%
CREATE	2.78%	2.47%	2.82%	5.56%	4.60%	5.88%

Further analysis of the ELA CCSS in grades K-5 revealed there are 486 unique standards. Of the 486 ELA Standards, 76 are written at the "remember" level. That is 15.64% of all K-5 ELA CCSS (see Figure 2). Twenty of the 76 "remember" standards were in kindergarten compared to only seven in fifth grade. This observation would appear to offer an explanation for the ability of a teaching strategy with a lower processing score to meet more standards at the kindergarten level than at the fourth grade level.

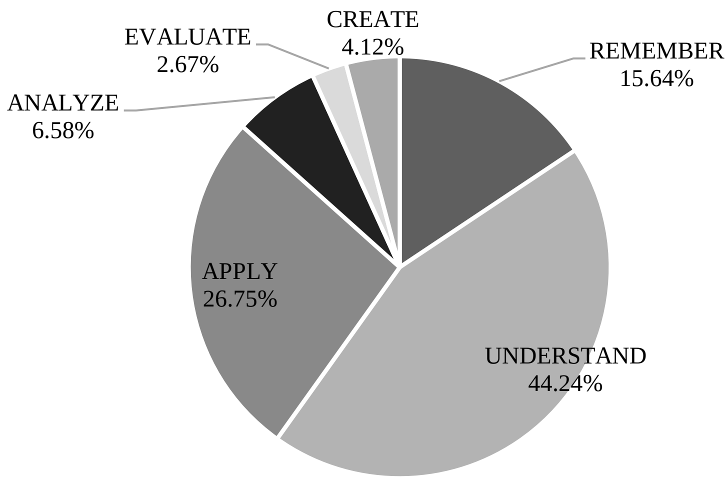

Figure 2. Percentage of ELA CCSS at each level of the revised Bloom's Taxonomy.

At the other end of the cognitive processing spectrum, PBL standards five – with guidance and support from adults and peers, collaboratively produce a tangible product which addresses the driving question or problem to be solved – and six – publicly unveil the product to an audience for review – were shown to meet or exceed the cognitive processing demands of 100% of the ELA CCSS at each grade level. Both of these PBL standards are in the "create" level of Bloom's taxonomy and are both in the "produce" sub-level of "create."

According to the quantified levels of the revised Bloom's taxonomy, the potential cognitive processing level assigned to these standards is 6.3. the highest level of cognitive processing available as measured by the numerically-scaled comparison defined by the revised Bloom's taxonomy. This means that these two standards when used as instructional strategies in the classroom have the potential to meet or exceed the cognitive processing levels of 100% of the ELA CCSS at every grade level K-5.

Research Question 4. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL in grades K-5? A single factor ANOVA was used to test for differences between the cognitive processing levels of the Standards of PBL and the cognitive processing levels of the K-5 ELA CCSS (see Table 12).

Table 12

K-5 ELA CCSS: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	31.37	1.00	31.37	22.25	0.00	3.86
Within Groups	690.69	490.00	1.41			
Total	722.06	491.00				

An alpha level of .05 was used in this analysis which resulted in a significance level of 95%. The single factor ANOVA revealed a difference in cognitive processing levels between the two sets of standards, F (1, 490) = 22.25483, p = .000. Tukey post-hoc comparisons of both sets of standards indicated that the cognitive processing levels of the Standards of PBL (M = 5, 95% CI [3.26, 6.745]) were significantly higher than the cognitive processing levels of the K-5 ELA CCSS (M = 2.699, 95% CI [2.594, 2.805]).

The alpha level was set at .05 which revealed the level for Tukey's "Honestly Significant Difference" to be .15004. The difference was found to be statistically significant at 2.300617 (see Table 13). Therefore, the null hypothesis was rejected. There was evidence to support the claim that there was a statistically significant difference in the cognitive processing levels of the K-5 ELA CCSS and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy.

Table 13

K-5 ELA CCSS Post Hoc Tukey Test

Groups	*Count*	*Sum*	*Mean*	*Variance*
K-5 ELA CCSS	486.00	1311.90	2.70	1.40
PBL	6.00	30.00	5.00	2.76
α	0.05			
HSD	0.15			
Mean Difference	2.30			

Research Question 4a. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the kindergarten grade level? A single factor ANOVA was used to test for differences between the cognitive processing levels of the Standards of PBL and the cognitive processing levels of the kindergarten ELA CCSS (see Table 14).

Table 14

Kindergarten ELA CCSS: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	39.14	1.00	39.14	26.93	0.00	3.97
Within Groups	110.48	76.00	1.45			
Total	149.61	77.00				

An alpha level of .05 was used in this analysis which resulted in a significance level of 95%. The single factor ANOVA revealed a difference in cognitive processing levels between the two sets of standards, F (1, 76) = 26.92512, p = .000. Tukey post-hoc comparisons of both sets of standards indicated that the cognitive processing levels of the Standards of PBL (M = 5, 95% CI [3.26, 6.745]) were significantly higher than the

cognitive processing levels of the kindergarten ELA CCSS (*M* = 2.342, 95% *CI [*2.067, 2.616]).

The alpha level was set at .05 which revealed the level for Tukey's "Honestly Significant Difference" to be .401968. The difference was found to be statistically significant at 2.658333 (see Table 15). Therefore, the null hypothesis was rejected. There was evidence to support the claim there was a statistically significant difference in the cognitive processing levels of the kindergarten ELA CCSS and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy.

Table 15

Kindergarten ELA CCSS Post Hoc Tukey Test

Groups	*Count*	*Sum*	*Mean*	*Variance*
K	72.00	168.60	2.34	1.36
PBL	6.00	30.00	5.00	2.76
α	0.05			
HSD	0.40			
Mean Difference	2.66			

Research Question 4b. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the first grade level? A single factor ANOVA was used to test for differences between the cognitive processing levels of the Standards of PBL and the cognitive processing levels of the first grade ELA CCSS (see Table 16).

Table 16

First Grade ELA CCSS: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	33.79	1.00	33.79	25.87	0.00	3.95
Within Groups	111.02	85.00	1.31			
Total	144.80	86.00				

An alpha level of .05 was used in this analysis which resulted in a significance level of 95%. The single factor ANOVA revealed a difference in cognitive processing levels between the two sets of standards, F (1, 85) = 25.86787, p = .000. Tukey post-hoc comparisons of both sets of standards indicated that the cognitive processing levels of the Standards of PBL (*M* = 5, 95% *CI* [3.26, 6.745]) were significantly higher than the cognitive processing levels of the 1st grade ELA CCSS (*M* = 2.514, 95% *CI* [2.297, 2.784]).

The alpha level was set at .05 which revealed the level for Tukey's "Honestly Significant Difference" to be .357326. The difference was found to be statistically significant at 2.459259 (see Table 17). Therefore the null hypothesis was rejected. There was evidence to support the claim there was a statistically significant difference in the cognitive processing levels of the first grade ELA CCSS and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy.

Table 17

First Grade ELA CCSS Post Hoc Tukey Test

Groups	*Count*	*Sum*	*Mean*	*Variance*
First Grade	81.00	205.80	2.54	1.21
PBL	6.00	30.00	5.00	2.76
α	0.05			
HSD	0.36			
Mean Difference	2.46			

Research Question 4c. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the second grade level? A single factor ANOVA was used to test for differences between the cognitive processing levels of the Standards of PBL and the cognitive processing levels of the second grade ELA CCSS (see Table 18).

Table 18

Second Grade ELA CCSS: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	36.43	1.00	36.43	27.75	0.00	3.97
Within Groups	98.46	75.00	1.31			
Total	134.89	76.00				

An alpha level of .05 was used in this analysis which resulted in a significance level of 95%. The single factor ANOVA revealed a difference in cognitive processing levels between the two sets of standards, F (1, 75) = 27.75271, p = .000. Tukey post-hoc comparisons of both sets of standards indicated that the cognitive processing levels of the Standards of PBL (M = 5, 95% *CI* [3.26, 6.745]) were significantly higher than the cognitive processing levels of the 5th grade ELA CCSS (M = 2.434, 95% *CI* [2.174, 2.694]).

The alpha level was set at .05 which revealed the level for Tukey's "Honestly Significant Difference" to be .384681. The difference was found to be statistically significant at 2.566197 (see Table 19). Therefore, the null hypothesis was rejected. There was evidence to support the claim there was a statistically significant difference in the cognitive processing levels of the second grade ELA CCSS and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy.

Table 19

Second Grade ELA CCSS Post Hoc Tukey Test

Groups	*Count*	*Sum*	*Mean*	*Variance*
Second Grade	71.00	172.80	2.43	1.21
PBL	6.00	30.00	5.00	2.76
α	0.05			
HSD	0.38			
Mean Difference	2.57			

Research Question 4d. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the third grade level? A single factor ANOVA was used to test for differences between the cognitive processing levels of the Standards of PBL and the cognitive processing levels of the third grade ELA CCSS (see Table 20).

Table 20

Third Grade ELA CCSS: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	27.69	1.00	27.69	17.18	0.00	3.94
Within Groups	151.54	94.00	1.61			
Total	179.23	95.00				

An alpha level of .05 was used in this analysis which resulted in a significance level of 95%. The single factor ANOVA revealed a difference in cognitive processing levels between the two sets of standards, F (1, 94) = 17.17909, p = .000. Tukey post-hoc comparisons of both sets of standards indicated that the cognitive processing levels of the Standards of PBL (M = 5, 95% CI [3.26, 6.745]) were significantly higher than the cognitive processing levels of the 3rd grade ELA CCSS (M =2.781, 95% CI [2.521, 3.042]).

The alpha level was set at .05 which revealed the level for Tukey's "Honestly Significant Difference" to be .376617. The difference was found to be statistically significant at 2.21889 (see Table 21). Therefore, the null hypothesis was rejected. There was evidence to support the claim there was a statistically significant difference in the cognitive processing levels of the third grade ELA CCSS and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy.

Table 21

Third Grade ELA CCSS Post Hoc Tukey Test

Groups	*Count*	*Sum*	*Mean*	*Variance*
Third Grade	90.00	250.30	2.78	1.55
PBL	6.00	30.00	5.00	2.76
α	0.05			
HSD	0.38			
Mean Difference	2.22			

Research Question 4e. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the 4th grade level? A one-way ANOVA was used to test for differences between the cognitive processing levels of the

Standards of PBL and the cognitive processing levels of the 4th grade ELA CCSS (see Table 22).

Table 22

Fourth Grade ELA CCSS: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	22.32	1.00	22.32	16.11	0.00	3.95
Within Groups	126.13	91.00	1.39			
Total	148.45	92.00				

An alpha level of .05 was used in this analysis which resulted in a significance level of 95%. The single factor ANOVA revealed a difference in cognitive processing levels between the two sets of standards, F (1, 91) = 16.10575, p = .000. Tukey post-hoc comparisons of both sets of standards indicated that the cognitive processing levels of the Standards of PBL (M = 5, 95% *CI* [3.26, 6.745]) were significantly higher than the cognitive processing levels of the 4th grade ELA CCSS (M = 3.006, 95% *CI* [2.762, 3.249]).

The alpha level was set at .05 which revealed the level for Tukey's "Honestly Significant Difference" to be .35518. The difference was found to be statistically significant at 1.994253 (see Table 23). Therefore, the null hypothesis was rejected. There was evidence to support the claim there was a statistically significant difference in the cognitive processing levels of the fourth grade ELA CCSS and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy.

Table 23

Fourth Grade ELA CCSS Post Hoc Tukey Test

Groups	*Count*	*Sum*	*Mean*	*Variance*
4^{th} Grade	87.00	261.50	3.01	1.31
PBL	6.00	30.00	5.00	2.76
α	0.05			
HSD	0.36			
Mean Difference	1.99			

Research Question 4f. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the fifth grade level? A one-way ANOVA was used to test for differences between the cognitive processing levels of the Standards of PBL and the cognitive processing levels of the fifth grade ELA CCSS (see Table 24).

Table 24

Fifth Grade ELA CCSS: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	22.97	1.00	22.97	15.65	0.00	3.95
Within Groups	130.68	89.00	1.47			
Total	153.65	90.00				

An alpha level of .05 was used in this analysis which resulted in a significance level of 95%. The single factor ANOVA revealed a difference in cognitive processing levels between the two sets of standards, F (1, 89) = 15.64731, p = .000. Tukey post-hoc comparisons of both sets of standards indicated that the cognitive processing levels of the Standards of PBL (M = 5, 95% *CI* [3.26, 6.745]) were significantly higher than the cognitive processing levels of the 5^{th} grade ELA CCSS (M = 2.98, 95% *CI* [2.72, 3.230]).

The alpha level was set at .05 which revealed the level for Tukey's "Honestly Significant Difference" to be .577743. The difference was found to be statistically significant at 2.0247 (see Table 25). Therefore, the null hypothesis was rejected. There was evidence to support the claim there was a statistically significant difference in the cognitive processing levels of the fifth grade ELA CCSS and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy.

Table 25

Fifth Grade ELA CCSS Post Hoc Tukey Test

Groups	*Count*	*Sum*	*Mean*	*Variance*
Fifth Grade	85.00	252.90	2.98	1.39
PBL	6.00	30.00	5.00	2.76
α	0.05			
HSD	0.37			
Mean Difference	2.02			

In summary, the average number of ELA CCSS met or exceeded by individual Standards of PBL was 87.19%. However, when the Standards of PBL are utilized in conjunction with one another, they have the potential to meet or exceed the cognitive processing demands of 100% of the K-5 ELA CCSS.

Research Question 5: Do the potential cognitive processing levels of the Standards of PBL meet or exceed the cognitive processing demands of a majority of the MA CCSS in grades K-5?

According to the quantitative analysis of the MA CCSS, grades K-5 and the Standards of PBL as measured by a numerically-scaled comparison to the language defined by the revised Bloom's taxonomy (Anderson & Krathwohl, 2001; Gallia, 2012), it was concluded that using a combination of all six Standards of PBL as an instructional strategy has the potential to meet the cognitive rigor demands of 100% of the MA CCSS.

On average, each standard of PBL can potentially reach the cognitive processing demands of 85.14% of the MA CCSS in grades K-5. PBL standards two through six each met the cognitive rigor of at least 88.94% of the MA CCSS at each grade level. PBL standard one, however, was only able to meet the cognitive rigor of an average 26.65% of the MA CCSS at any given grade level. In fact, standard one, when used as an isolated instructional strategy, was shown to be most effective in kindergarten where it has the potential to meet the cognitive rigor level of 44% of the kindergarten MA CCSS. That percentage fell as the grade levels increased. It reached its lowest point of effectiveness in the fourth grade, where it has the potential to only meet the cognitive demands of 14.29% of the MA CCSS. The MA CCSS met by each standard of PBL can be seen in Table 26.

Table 26

Percentage of MA CCSS Met by Each PBL Standard

	K	1st	2nd	3rd	4th	5th	OVERALL
PBL 1	44.00%	23.81%	26.92%	31.43%	14.29%	19.44%	26.65%
PBL 2	96.00%	100.00%	96.15%	100.00%	100.00%	91.67%	97.30%
PBL 3	96.00%	100.00%	100.00%	100.00%	100.00%	91.67%	97.94%
PBL 4	80.00%	95.24%	92.31%	94.29%	85.71%	86.11%	88.94%
PBL 5	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
PBL 6	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
OVERALL	86.00%	86.51%	85.90%	87.62%	83.33%	81.48%	85.14%

An analysis of the cognitive processing levels of the MA CCSS by grade level revealed some explanation for this outcome (see Table 27). PBL standard one – define or explain the driving question or problem to be solved – had a cognitive processing value of 2.1. This value is the lowest value in the second level of the revised Bloom's Taxonomy (understand). This means PBL 1 offers only enough cognitive processing potential to slightly exceed the demands of the lowest level of Bloom's taxonomy (remember). This would only account for 44.00% of the MA CCSS standards which are written at the "remember" level. Further analysis of the standards which cognitive processing demands fall within the "understand" level showed that, of the 15 "understand" standards at the kindergarten level, 10, or 67.00% were at 2.1. This means that the first standard of PBL has the potential to reach the level of cognitive processing demanded by 44.00% of the kindergarten MA CCSS.

Table 27 shows that the percentage of MA CCSS at the "remember" level was at its peak in first and third grade where 14.29% of the standards were at this level. The trend line for the MA CCSS written at the "remember" level was at its lowest in kindergarten where only 4% of the standards were at this level.

Table 27

Percentage of MA CCSS at Each Level of Bloom's Revised Taxonomy

	K	1st	2nd	3rd	4th	5th
REMEMBER	4.00%	14.29%	7.69%	14.29%	8.57%	11.11%
UNDERSTAND	60.00%	57.14%	42.31%	57.14%	48.57%	41.67%
APPLY	8.00%	19.05%	42.31%	22.86%	25.71%	33.33%
ANALYZE	20.00%	9.52%	3.85%	5.71%	17.14%	5.56%
EVALUATE	4.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CREATE	4.00%	0.00%	3.85%	0.00%	0.00%	8.33%

Taking a closer look at the K-5 MA CCSS, there are 178 different standards. Of the 178 MA Standards, 18 of them are written at the "remember" level. That is only 10.11% of all K-5 MA CCSS. Eight of the 18 "remember" standards are in first and third grades combined, compared to only one in kindergarten. This is due, in large part, to the wording of the kindergarten standards, which routinely ask students to "count," "write," and "describe." All of these action verbs fall in the "understand" level with a cognitive processing level of 2.1, a slightly higher cognitive processing level than that of the "remember" level.

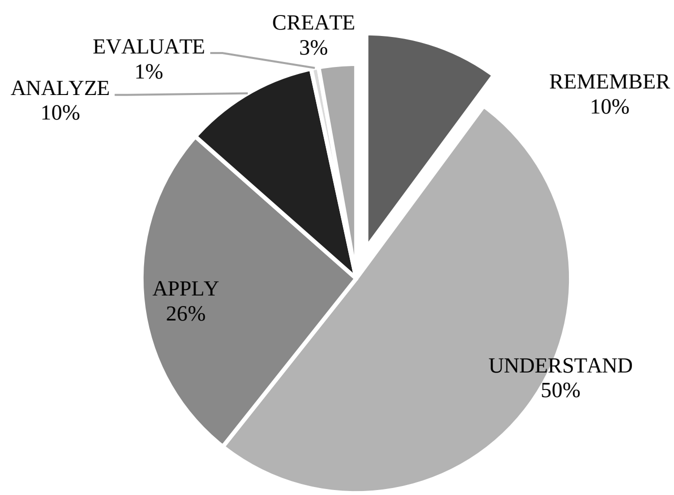

Figure 3. Percentage of MA standards at each level of the revised Bloom's Taxonomy.

At the other end of the cognitive processing spectrum, PBL standards five – with guidance and support from adults and peers, collaboratively produce a tangible product which addresses the driving question or problem to be solved – and six – publicly unveil the product to an audience for review – were shown to meet or exceed the cognitive processing demands of 100% of the MA CCSS at each grade level. Both of these PBL standards are in the "create" level of Bloom's taxonomy and are both in the "produce" sub-level of "create."

According to the quantified levels of the revised Bloom's taxonomy, the potential cognitive processing level assigned to these standards is 6.3. This is the highest level of cognitive processing available as measured by the numerically-scaled comparison defined by the revised Bloom's taxonomy. This means these two standards, when used as instructional strategies in the classroom, have the potential to meet or exceed the cognitive processing levels of 100% of the MA CCSS at every grade level K-5.

Research Question 6. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL in grades K-5? A single factor ANOVA was used to test for differences between the cognitive processing levels of the Standards of PBL and the cognitive processing levels of the K-5 MA CCSS (see Table 28).

Table 28

K-5 MA CCSS: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	30.00	1.00	30.00	27.45	0.00	3.89
Within Groups	198.95	182.00	1.09			
Total	228.95	183.00				

An alpha level of .05 was used in this analysis which resulted in a significance level of 95%. The single factor ANOVA revealed a difference in cognitive processing levels between the two sets of standards, F (1, 182) = 27.44835, p = .000. Tukey post-hoc comparisons of both sets of standards indicated that the cognitive processing levels of the Standards of PBL (*M* = 5, 95% *CI* [3.26, 6.745]) were significantly higher than the cognitive processing levels of the 5th grade ELA CCSS (*M* = 2.726, 95% *CI* [2.575, 2.878]).

The alpha level was set at .05 which revealed the critical level for Tukey's "Honestly Significant Difference" to be .219422. The difference was found to be statistically significant at 2.273596 (see Table 28). Therefore, the null hypothesis was rejected. There was evidence to support the claim there was a statistically significant difference in the cognitive processing levels of the K-5 MA CCSS and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy.

Table 29

K-5 MA CCSS Post Hoc Tukey Test

Groups	*Count*	*Sum*	*Mean*	*Variance*
K-5 MA CCSS	178.00	485.30	2.73	1.05
PBL	6.00	30.00	5.00	2.76
α	0.05			
HSD	0.22			
Mean Difference	2.27			

Research Question 6a. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the kindergarten grade level? A single factor ANOVA was used to test for differences between the cognitive processing levels of the Standards of PBL and the cognitive processing levels of the kindergarten MA CCSS (see Table 29).

Table 30

Kindergarten MA CCSS: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	21.26	1.00	21.26	12.30	0.00	4.18
Within Groups	50.13	29.00	1.73			
Total	71.39	30.00				

An alpha level of .05 was used in this analysis, which resulted in a significance level of 95%. The single factor ANOVA revealed a difference in cognitive processing levels between the two sets of standards, F (1, 29) = 12.29747, p = .000. Tukey post-hoc comparisons of both sets of standards indicated that the cognitive processing levels of the Standards of PBL (M = 5, 95% *CI* [3.26, 6.745]) were significantly higher than the cognitive processing levels of the kindergarten MA CCSS (M = 2.904, 95% *CI* [2.396, 3.412]).

The alpha level was set at .05 which revealed the critical level for Tukey's "Honestly Significant Difference" to be .76046. The difference was found to be statistically significant at 2.096 (see Table 30). Therefore, the null hypothesis was rejected. There was evidence to support the claim there was a statistically significant difference in the cognitive processing levels of the kindergarten MA CCSS and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy.

Table 31

Kindergarten MA CCSS Post Hoc Tukey Test

Groups	*Count*	*Sum*	*Mean*	*Variance*
Kindergarten	25.00	72.60	2.90	1.51
PBL	6.00	30.00	5.00	2.76
α	0.05			
HSD	0.76			
Mean Difference	2.10			

Research Question 6b. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the first grade level? A single factor ANOVA was used to test for differences between the cognitive processing levels of the Standards of PBL and the cognitive processing levels of the first grade MA CCSS (see Table 31).

Table 32

First Grade MA CCSS: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	29.72	1.00	29.72	26.47	0.00	4.24
Within Groups	28.08	25.00	1.12			
Total	57.80	26.00				

An alpha level of .05 was used in this analysis which resulted in a significance level of 95%. The single factor ANOVA revealed a difference in cognitive processing levels between the two sets of standards, F (1, 25) = 26.46624, p = .000. Tukey post-hoc comparisons of both sets of standards indicated that the cognitive processing levels of the Standards of PBL (M = 5, 95% CI [3.26, 6.745]) were significantly higher than the

cognitive processing levels of the first grade MA CCSS (*M* = 2.476, 95% *CI* [2.092, 2.861]).

The alpha level was set at .05 which revealed the critical level for Tukey's "Honestly Significant Difference" to be .673667. The difference was found to be statistically significant at 2.52381 (see Table 32). Therefore, the null hypothesis was rejected. There was evidence to support the claim there was a statistically significant difference in the cognitive processing levels of the first grade MA CCSS and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy.

Table 33

First Grade MA CCSS Post Hoc Tukey Test

Groups	*Count*	*Sum*	*Mean*	*Variance*
First Grade	21.00	52.00	2.48	0.71
PBL	6.00	30.00	5.00	2.76
α	0.05			
HSD	0.67			
Mean Difference	2.52			

Research Question 6c. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the second grade level? A single factor ANOVA was used to test for differences between the cognitive processing levels of the Standards of PBL and the cognitive processing levels of the second grade MA CCSS (see Table 33).

Table 34

Second Grade MA CCSS: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	23.76	1.00	23.76	18.91	0.00	4.17
Within Groups	37.70	30.00	1.26			
Total	61.46	31.00				

An alpha level of .05 was used in this analysis, which resulted in a significance level of 95%. The single factor ANOVA revealed a difference in cognitive processing levels between the two sets of standards, F (1, 30) = 18.90816, p = .000. Tukey post-hoc comparisons of both sets of standards indicated that the cognitive processing levels of the Standards of PBL (M = 5, 95% *CI* [3.26, 6.745]) were significantly higher than the cognitive processing levels of the second grade MA CCSS (M = 2.792, 95% *CI* [2.398, 3.187]).

The alpha level was set at .05 which revealed the critical level for Tukey's "Honestly Significant Difference" to be .634909. The difference was found to be statistically significant at 2.207692 (see Table 34). Therefore, the null hypothesis was rejected. There was evidence to support the claim there was a statistically significant difference in the cognitive processing levels of the second grade MA CCSS and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy.

Table 35

Second Grade MA CCSS Post Hoc Tukey Test

Groups	*Count*	*Sum*	*Mean*	*Variance*
Second Grade	26.00	72.60	2.79	0.96
PBL	6.00	30.00	5.00	2.76
α	0.05			
HSD	0.63			
Mean Difference	2.21			

Research Question 6d. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the 3rd grade level? A single factor ANOVA was used to test for differences between the cognitive processing levels of the Standards of PBL and the cognitive processing levels of the third grade MA CCSS (see Table 35).

Table 36

Third Grade MA CCSS: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	32.45	1.00	32.45	35.80	0.00	4.09
Within Groups	35.35	39.00	0.91			
Total	67.80	40.00				

An alpha level of .05 was used in this analysis which resulted in a significance level of 95%. The single factor ANOVA revealed a difference in cognitive processing levels between the two sets of standards, F (1, 39) = 35.80386, p = .000. Tukey post-hoc comparisons of both sets of standards indicated that the cognitive processing levels of the Standards of PBL (M = 5, 95% CI [3.26, 6.745]) were significantly higher than the

cognitive processing levels of the 3rd grade MA CCSS (*M* = 2.483, 95% *CI* [2.210, 2.756]).

The alpha level was set at .05 which revealed the critical level for Tukey's "Honestly Significant Difference" to be .46041. The difference was found to be statistically significant at 2.517143 (see Table 36). Therefore, the null hypothesis was rejected. There was evidence to support the claim there was a statistically significant difference in the cognitive processing levels of the third grade MA CCSS and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy.

Table 37

Third Grade MA CCSS Post Hoc Tukey Test

Groups	*Count*	*Sum*	*Mean*	*Variance*
Third Grade	35.00	86.90	2.48	0.63
PBL	6.00	30.00	5.00	2.76
α	0.05			
HSD	0.46			
Mean Difference	2.52			

Research Question 6e. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the fourth grade level? A single factor ANOVA was used to test for differences between the cognitive processing levels of the Standards of PBL and the cognitive processing levels of the fourth grade MA CCSS (see Table 37).

Table 38

Fourth Grade MA CCSS: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	25.63	1.00	25.63	24.67	0.00	4.09
Within Groups	40.52	39.00	1.04			
Total	66.16	40.00				

An alpha level of .05 was used in this analysis which resulted in a significance level of 95%. The single factor ANOVA revealed a difference in cognitive processing levels between the two sets of standards, F (1, 39) = 24.67173, p = .000. Tukey post-hoc comparisons of both sets of standards indicated that the cognitive processing levels of the Standards of PBL (M = 5, 95% *CI* [3.26, 6.745]) were significantly higher than the cognitive processing levels of the 4^{th} grade MA CCSS (M = 2.763, 95% *CI* [2.458, 3.067]).

The alpha level was set at .05 which revealed the critical level for Tukey's "Honestly Significant Difference" to be .492942. The difference was found to be statistically significant at 2.237143 (see Table 38). Therefore, the null hypothesis was rejected. There was evidence to support the claim there was a statistically significant difference in the cognitive processing levels of the fourth grade MA CCSS and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy.

Table 39

Fourth Grade MA CCSS Post Hoc Tukey Test

Groups	*Count*	*Sum*	*Mean*	*Variance*
Fourth Grade	35.00	96.70	2.76	0.79
PBL	6.00	30.00	5.00	2.76
α	0.05			
HSD	0.49			
Mean Difference	2.24			

Research Question 6f. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the fifth grade level? A single factor ANOVA was used to test for differences between the cognitive processing levels of the Standards of PBL and the cognitive processing levels of the fifth grade MA CCSS (see Table 39).

Table 40

Fifth Grade MA CCSS: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	22.62	1.00	22.62	12.78	0.00	4.08
Within Groups	70.81	40.00	1.77			
Total	93.41	41.00				

An alpha level of .05 was used in this analysis which resulted in a significance level of 95%. The single factor ANOVA revealed a difference in cognitive processing levels between the two sets of standards, F (1, 40) = 12.77793, p = .001. Tukey post-hoc comparisons of both sets of standards indicated that the cognitive processing levels of the Standards of PBL (M = 5, 95% CI [3.26, 6.745]) were significantly higher than the

cognitive processing levels of the 5th grade MA CCSS (M = 2.763, 95% CI [2.458, 3.067]).

The alpha level was set at .05 which revealed the critical level for Tukey's "Honestly Significant Difference" to be .633764. The difference was found to be statistically significant at 2.097222 (see Table 40). Therefore, the null hypothesis was rejected. There was evidence to support the claim there was a statistically significant difference in the cognitive processing levels of the fifth grade MA CCSS and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy.

Table 41

Fifth Grade MA CCSS Post Hoc Tukey Test

Groups	*Count*	*Sum*	*Mean*	*Variance*
Fifth Grade	36.00	104.50	2.90	1.63
PBL	6.00	30.00	5.00	2.76
α	0.05			
HSD	0.63			
Mean Difference	2.10			

In summary, when used as individual instructional strategies, the Standards of PBL met or exceeded an average of 81.48% of the standards at any given grade level. However, when the Standards of PBL are utilized in conjunction with one another, they have the potential to meet or exceed the cognitive rigor requirements of 100% of the K-5 MA CCSS.

Research Question 7: Do the potential cognitive processing levels of the Standards of PBL meet the cognitive processing demands of a majority of the ISTE Standards-S?

According to the quantitative analysis of the ISTE Standards-S and the standards for PBL, as measured by a numerically-scaled comparison to the language defined by the revised Bloom's taxonomy (Anderson & Krathwohl, 2001; Gallia, 2012), it was surmised that using a combination of all six PBL standards as an instructional strategy has the potential to meet the cognitive processing level of 100% of ISTE Standards-S (see Table 41).

Table 42

Number and Percentage of ISTE Standards Met by each PBL Standard

PBL Standard	Number of ISTE Standards Met	% of ISTE Standards-S Met
PBL 1	3.00	12.50%
PBL 2	16.00	66.67%
PBL 3	18.00	75.00%
PBL 4	11.00	45.83%
PBL 5	24.00	100.00%
PBL 6	24.00	100.00%

On average, each standard of PBL can potentially reach the cognitive processing level of 66.67% of ISTE Standards-S. PBL standards one and four, however, were only able to reach the cognitive processing levels of 12.5% and 45.83%, respectively, which was below the average of the ISTE Standards-S met by each standard of PBL. PBL standard one – define or explain the driving question or problem to be solved – had a cognitive processing value of 2.1. This value was the lowest value in the second level of the revised Bloom's Taxonomy (understand). This means this particular standard of PBL offered only enough cognitive processing potential to slightly exceed the cognitive processing demands of the lowest level of Bloom's taxonomy (remember).

As there were no ISTE Standards-S written at the “remember” level, PBL standard one had only enough cognitive processing potential to meet the cognitive processing demands of 12.5% of the ISTE Standards-S. PBL standards two and three met the cognitive processing levels of 66.67% and 75%, respectively. This was above the average of the ISTE Standards-S met by each standard of PBL.

In contrast, PBL standards five – with guidance and support from adults and peers, collaboratively produce a tangible product which addresses the driving question or problem to be solved – and six – publicly unveil the product to an audience for review – were shown to meet or exceed the cognitive processing demands of 100% of the ISTE Standard-S. Both of these Standards of PBL are in the “create” level of Bloom’s taxonomy and are both in the “produce” sub-level of “create.”

According to the quantified levels of the revised Bloom’s taxonomy, the potential cognitive processing level assigned to these standards is 6.3. This is the highest level of cognitive processing available as measured by the numerically-scaled comparison defined by the revised Bloom’s taxonomy. This means that these two standards, when used as instructional strategies in the classroom, have the potential to meet or exceed the cognitive processing levels of 100% of the ISTE Standards-S.

A closer look at the ISTE Standards-S revealed some explanation for this phenomenon. The ISTE has 24 standards for students. Of these 24 standards, seven are written at the “create” level of Bloom’s taxonomy and are considered the highest level of cognitive processing. Conversely, zero of the ISTE standards for students are written at the “remember” level (see Table 42). This disparity was indicative of the cognitive processing level at which the ISTE standards for students were written.

Table 43

Number and Percentage of ISTE Standards at each Bloom's Level

	Number of Standards	Percentage of Standards
REMEMBER	0.00	0.00%
UNDERSTAND	5.00	20.83%
APPLY	6.00	25.00%
ANALYZE	1.00	4.17%
EVALUATE	5.00	20.83%
CREATE	7.00	29.17%
TOTAL	24.00	100.00%

Research Question 8. What is the difference in the mean cognitive processing levels of the ISTE Standards-S and the Standards of PBL? A single factor ANOVA was used to test for differences between the cognitive processing levels of the Standards of PBL and the cognitive processing levels of the ISTE Standards-S (see Table 44).

Table 44

ISTE Standards-S: PBL ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	2.13	1.00	2.13	0.83	0.37	4.20
Within Groups	72.25	28.00	2.58			
Total	74.39	29.00				

An alpha level of .05 was used in this analysis which resulted in a significance level of 95%. The single factor ANOVA revealed no difference in cognitive processing levels between the two sets of standards, F (1, 28) = 0.826721, p = .371. There was no evidence to support the claim there was a statistically significant difference in the cognitive processing levels of the ISTE Standards-S and the Standards of PBL as measured by the quantified language of the revised Bloom's Taxonomy. Therefore, the null hypothesis could not be rejected.

In summary, there was no statistically significant difference between the mean cognitive processing levels of the ISTE Standards-S and the Standards of PBL. It was also found that the average number of the ISTE Standards-S met or exceeded by the individual Standards of PBL was 66.67%. However, when the Standards of PBL are utilized in conjunction with one another, they have the potential to meet or exceed the cognitive processing demands of 100% of the ISTE Standards-S.

Summary

This chapter was focused on the results of the study conducted. Eight questions were posed, analyzed, and answered. In the case of each question, a statistical analysis was produced. The comparative analysis of cognitive processing levels led to the determination that teachers using all six of the Standards of PBL in their classrooms would be able to meet or exceed the cognitive processing levels required by the CCSS. In fact, when all six Standards of PBL are used in conjunction, teachers have the ability to reach or exceed the cognitive processing levels required by all the K-5 CCSS in both ELA and MA.

The comparative analysis was followed by an in-depth statistical analysis and comparison of the mean cognitive processing levels of each set of standards. These single factor ANOVAs led to the conclusion there were differences in the overall cognitive processing levels between the CCSS and the Standards of PBL. Tukey tests were then run and determined the differences to be statistically significant. While initial comparisons showed the Standards of PBL able to meet 100% of the ISTE Standards-S, a further single factor analysis of variance identified no statistical difference between the cognitive processing levels of these two sets of standards. In Chapter Five is a discussion of a summary of the study and recommendations for further research.

Chapter Five: Discussion and Reflection

This study was a quantitative analysis of cognitive processing potential versus demand. The process began by selecting and quantifying two sets of standards which were written to set the expectation of what students should be able to know and do when they complete their K-12 schooling in the 21st century (ISTE, 2007; National Governers Association Center for Best Practices, Council of Chief State School Officers, 2010). These standards were then compared against a standardized instructional method.

The Common Core State Standards (CCSS) were selected to represent bureaucratically adopted academic content standards (Missouri Department of Elementary and Secondary Education, 2013). The ISTE Standards-S were selected to represent a grassroots 21st century skills movement (ISTE, 2007). Project-based Learning (PBL) was selected as an instructional strategy which was deemed able to meet the demands of both sets of standards (Ross, 2012).

When considering whether PBL could be used to meet the standards, the issue of the research on PBL was wide and varied presented a challenge (Thomas, 2000). There were many authorities who established “rules” and “essentials” for PBL (Larmer & Mergendoller, 2010; Markham, 2012; Vega, 2012). However, there were no universally accepted models of what PBL should look like in the classroom (Savery, 2006).

In an effort to create a study which could be replicated or extended, a baseline framework for PBL in the classroom was needed for effective comparisons to the CCSS and the ISTE Standards-S. To complete this task, a content analysis was conducted of 10 scholarly resources on PBL to produce a list of common components. These components were considered common because they were referenced in each of the scholarly resources on PBL.

A total of six components were identified through this process as common. From these six components, six Standards of PBL were composed, which could potentially be used and replicated in multiple classroom settings with similar results. Anderson and Krathwohl's (2001) book, *A Taxonomy for Learning Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*, was used as the framework for how the Standards of PBL would be written.

Once the Standards of PBL were written, comparative analyses were conducted. These analyses led to the determination that 100% of the CCSS and ISTE Standards-S could potentially be met by using the Standards of PBL as an instructional strategy in the classroom. It was determined that a further analysis of the means of each set of standards was needed.

A series of single factor ANOVAs were conducted to compare the variances of each set of standards. These analyses allowed for the identification of the existence of statistically significant differences in cognitive processing languages between the standards. Through the use of an array of Tukey tests, it was found that the language used in the Standards of PBL was at a significantly higher cognitive processing level than the language used in the CCSS for both English Language Arts (ELA) and Math (MA). It was further determined there was no statistically significant difference in the cognitive processing languages of the Standards of PBL and the ISTE Standards-S.

Triangulation of Results

The guiding question of this study was: Can PBL be used as an effective teaching strategy to meet the 21st century needs of students in states who have adopted the CCSS? Based on the holistic findings of this study, the answer to that question was: *yes*. When teachers are able to utilize all six Standards of PBL they have the potential to meet or exceed the cognitive processing level required for both the CCSS as well as the ISTE Standards-S. To corroborate this determination, four slightly more specific research questions regarding the potential of teachers using PBL were posed. A summary of those questions, as well as their specific findings, have been outlined in the following sections.

Research question 1. Do the potential cognitive processing levels of the Standards of PBL meet or exceed the cognitive processing demands of a majority of the CCSS in grades K-5? After a comparison of cognitive processing levels of the Standards of PBL against the cognitive processing levels of the K-5 CCSS, it was determined that the Standards of PBL had the cognitive processing potential to meet or exceed the cognitive processing demands of a majority of the CCSS in grades K-5. In fact, if teachers used all six standards, they could potentially meet or exceed 100% of the combined K-5 CCSS.

Research Question 2. What is the difference in the mean cognitive processing levels of the CCSS and the Standards of PBL in grades K-5? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the K-5 CCSS revealed a statistical difference in means. A post hoc Tukey test was conducted to determine the significance of the difference. It was determined that the cognitive processing level of the Standards of PBL were significantly higher level than the cognitive processing level of the combined K-5 CCSS.

Research Question 3. Do the potential cognitive processing levels of the Standards of PBL meet or exceed the cognitive processing demands of a majority of the ELA CCSS in grades K-5? After a comparison of cognitive processing levels of the Standards of PBL against the cognitive processing levels of the K-5 ELA CCSS, it was determined that the Standards of PBL had the cognitive processing potential to meet or exceed the cognitive processing demands of a majority of the ELA CCSS in grades K-5.

In fact, if teachers used all six standards, they can potentially meet or exceed 100% of the combined K-5 ELA CCSS. A single factor ANOVA of the cognitive processing language further revealed a statistical difference between the Standards of PBL and the combined K-5 ELA CCSS. A Tukey test led to the determination that the mean cognitive processing language of the Standards of PBL were written at a significantly higher level than the mean cognitive processing language of the combined K-5 ELA CCSS.

Research Question 4. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL in grades K-5? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the K-5 ELA CCSS revealed a statistical difference in means. A post hoc Tukey test was conducted to determine the significance of the difference. It was determined that the cognitive processing level of the Standards of PBL were written at a significantly higher level than the cognitive processing level of the combined K-5 ELA CCSS.

Research Question 4a. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the kindergarten grade level? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the kindergarten ELA CCSS revealed a statistical difference in means. A post hoc Tukey test was conducted to determine the significance of the difference. It was determined that the cognitive processing level of the Standards of PBL were significantly higher level than the cognitive processing level of the combined kindergarten ELA CCSS.

Research Question 4b. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the 1st grade level? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the first grade ELA CCSS revealed a statistical difference in means. A post hoc Tukey test was conducted to determine the significance of the difference. It was determined that the cognitive processing level of the Standards of PBL were significantly higher level than the cognitive processing level of the combined first grade ELA CCSS.

Research Question 4c. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the second grade level? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the second grade ELA CCSS revealed a statistical difference in means. A post hoc Tukey test was conducted to determine the significance of the difference. It was determined that the cognitive processing level of the Standards of PBL were significantly higher level than the cognitive processing level of the combined second grade ELA CCSS.

Research Question 4d. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the third grade level? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the third grade ELA CCSS revealed a statistical difference in means. A post hoc Tukey test was conducted to determine the significance of the difference. It was determined that the cognitive processing level of the Standards of PBL were significantly higher level than the cognitive processing level of the combined third grade ELA CCSS.

Research Question 4e. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the fourth grade level? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the fourth grade ELA CCSS revealed a statistical difference in means. A post hoc Tukey test was conducted to determine the significance of the difference. It was determined that the cognitive processing level of the Standards of PBL were significantly higher level than the cognitive processing level of the combined fourth grade ELA CCSS.

Research Question 4f. What is the difference in the mean cognitive processing levels of the ELA CCSS and the Standards of PBL at the fifth grade level? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the fifth grade ELA CCSS revealed a statistical difference in means. A post hoc Tukey test was conducted to determine the significance of the difference. It was determined that the cognitive processing level of the Standards of PBL were significantly higher level than the cognitive processing level of the combined fifth grade ELA CCSS.

Research Question 5. Do the potential cognitive processing levels of the Standards of PBL meet or exceed the cognitive processing demands of a majority of the

MA CCSS in grades K-5? After a comparison of cognitive processing levels of the Standards of PBL against the cognitive processing levels of the K-5 MA CCSS, it was determined that the Standards of PBL have the cognitive processing potential to meet or exceed the cognitive processing demands of a majority of the MA CCSS in grades K-5.

If teachers used all six standards, they can potentially meet or exceed 100% of the combined K-5 MA CCSS. A single factor ANOVA of the cognitive processing language further revealed a statistical difference between the Standards of PBL and the combined K-5 MA CCSS. A Tukey test led to the determination that the mean cognitive processing language of the Standards of PBL were written at a significantly higher level than the mean cognitive processing language of the combined K-5 MA CCSS

Research Question 6. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL in grades K-5? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the K-5 MA CCSS revealed a statistical difference in means. A post hoc Tukey test was conducted to determine the significance of the difference. It was determined that the cognitive processing level of the Standards of PBL were significantly higher level than the cognitive processing level of the combined K-5 MA CCSS.

Research Question 6a. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the kindergarten grade level? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the kindergarten MA CCSS revealed a statistical difference in means. A post hoc Tukey test was conducted to determine the significance of the difference. It was determined that the cognitive processing level of the Standards of PBL were significantly higher level than the cognitive processing level of the combined kindergarten MA CCSS.

Research Question 6b. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the first grade level? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the first grade MA CCSS revealed a statistical difference in means. A post hoc Tukey test was conducted to determine the significance of the difference. It was determined that the cognitive processing level of the Standards of PBL were significantly higher level than the cognitive processing level of the combined first grade MA CCSS.

Research Question 6c. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the second grade level? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the second grade MA CCSS revealed a statistical difference in means. A post hoc Tukey test was conducted to determine the significance of the difference. It was determined that the cognitive processing level of the Standards of PBL were significantly higher level than the cognitive processing level of the combined second grade MA CCSS.

Research Question 6d. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the third grade level? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the third grade MA CCSS revealed a statistical difference in means. A post hoc Tukey test was conducted to determine the significance of the difference. It was determined that the cognitive processing level of the Standards of PBL were significantly higher level than the cognitive processing level of the combined third grade MA CCSS.

Research Question 6e. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the fourth grade level? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the fourth grade MA CCSS revealed a statistical difference in means. A post hoc Tukey test was conducted to determine the significance of the difference. It was determined that the cognitive processing level of the Standards of PBL were significantly higher level than the cognitive processing level of the combined fourth grade MA CCSS.

Research Question 6f. What is the difference in the mean cognitive processing levels of the MA CCSS and the Standards of PBL at the fifth grade level? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the fifth grade MA CCSS revealed a statistical difference in means. A post hoc Tukey test was conducted to determine the significance of the difference. It was determined that the cognitive processing level of the Standards of PBL were significantly higher level than the cognitive processing level of the combined fifth grade MA CCSS.

Research Question 7. Do the potential cognitive processing levels of the Standards of PBL meet or exceed the cognitive processing demands of a majority of the ISTE Standards-S? After a comparison of cognitive processing levels of the Standards of PBL against the cognitive processing levels of the ISTE Standards-S, it was determined that the Standards of PBL have the cognitive processing potential to meet or exceed the cognitive processing demands of a majority of the ISTE Standards-S. In fact, if teachers used all six standards, they can potentially meet or exceed 100% of the combined ISTE Standards-S.

Research Question 8. What is the difference in the mean cognitive processing levels of the ISTE Standards-S and the Standards of PBL? A single factor ANOVA comparing the cognitive processing levels of the Standards of PBL and the ISTE Standards-S revealed no statistical difference in means. This means the ISTE Standards-S and the Standards of PBL are written at a statistically similar cognitive processing level. As no statistical difference was uncovered, a post hoc test was not necessary.

Implications

With the CCSS going into full implementation during the 2014-2015 school year (Missouri Department of Elementary and Secondary Education, 2012), many teachers are searching for new instructional strategies rigorous enough to meet the new standards (Owocki, 2012). Many teachers are also looking for different teaching strategies which offers them the opportunity to develop their students into 21st century thinkers and contributors (Brennan, 2013). The results of this study could offer those teachers a research-based framework for an instructional strategy with the potential to guide their students to success in the areas of both academic and social achievement.

School leaders and professional development directors alike could use the results of this study to inform their decisions when working to schedule and create workshops for teacher development. When developing activities for professional development, they can use the information compiled in this study to focus on the individual Standards of PBL that have the most potential cognitive processing power (PBL 5 and PBL 6), or they can focus on all six Standards of PBL as one solid teaching strategy. This would be an effective, long-term approach to professional development for teachers interested in utilizing the PBL method in their classrooms (Markham, 2012).

Literature Justification.

This study substantiated the claims made in the literature supporting PBL as a rigorous enough approach to classroom instruction to be used as the "how" to meet the "what" of the CCSS (Ross, 2012). The research conducted throughout this study complimented and justified the sentiment encountered throughout much of the literature on PBL, which touted it as an instructional method which can be used in the classroom to develop and hone 21st century skills and abilities of students (Boss & Krauss, 2007). Nearly every source on the subject of PBL also cited increased student motivation in classrooms using PBL (Bender, 2012). This motivation was often found to push students to perform tasks at a much higher level of rigor.

The CCSS were developed under the assumption that, if the standards were raised, then achievement would follow (Bush, 2013). However, many have felt as though raising standards with frequent high-stakes assessments was counterproductive to the US education and economic systems (Zhao, 2009). Using PBL as a teaching strategy would seem to some to be the ideal educational tool for teachers caught between the two opposing viewpoints (Calkins, Ehrenworth, Mary, & Lehman, 2012).

This study found when all six Standards of PBL were utilized, the strategy was potentially rigorous enough to meet the cognitive processing demands of the CCSS as well as the cognitive processing demands of the 21st century skills identified in ISTE Standards-S. Due to this result, one could draw the conclusion that students taught using all six Standards of PBL should be able to find success in both scholastic achievement as well as the 21st century workplace. However, further action research must be conducted before that assertion could be validated.

Recommendations for Future Research

The next step for an extended study on the topic of PBL and the CCSS would be to take the Standards of PBL into the classroom for experimentation. This study has provided a standardized framework for instruction, which has the cognitive processing potential to meet the needs of 21st century students in states that have adopted the CCSS. However, actionable research must be conducted to determine if teachers using this framework have an actual impact on student mastery of the CCSS as well as the ISTE Standards-S.

This study could also be extended by comparing a variety of instructional strategies which align with the Standards of PBL framework outlined in this study to determine if one has more impact than another. To effectively conduct this research, a project-oriented strategy, such as educational filmmaking, would have to be identified. That same strategy would then have to be aligned to the PBL framework. This would be essential to gauge its impact as a PBL teaching strategy.

Another extended study could be conducted to compare the instructional impact of direct instruction versus PBL on student mastery of the CCSS. Since direct instruction is referenced as a 20th century instructional approach (Trilling & Fadel, 2009), and PBL is considered a 21st century approach (Boss & Krauss, 2007), this study could further justify the use of PBL in the classroom over more traditional approaches. A direct comparison of the two instructional strategies could potentially move teachers past "the sheer momentum of decades (or possibly centuries) of teaching practices based on transmitting knowledge to students through direct instruction," which is one of the forces identified by Trilling and Fadel (2009) responsible for keeping teachers from adopting 21st century teaching strategies (p. 35).

Personal Reflections and Recommendations

The CCSS can potentially provide the impetus for major reforms in instructional practice. However, with teacher evaluation tied to high stakes state assessments (Missouri Department of Elementary and Secondary Education, 2012), the fear to step outside of the norm and experiment is found to be higher than ever (Trilling & Fadel, 2009). While the philosophies behind PBL have been around for many years (Kauchak & Eggen, 2011), the PBL method has not been considered a mainstream approach to instruction (Zhao, 2012).

Traditional teaching practices which put the teacher in front of the class disseminating information through direct instruction, have proven effective enough to meet the needs of the workplace in the times preceding the Knowledge Age (Trilling & Fadel, 2009). However, as educators have moved toward a truly uncertain future, canned knowledge gained through traditional methods of instruction has been insufficient (Schwahn & McGarvey, 2011). The students of the early 21st century will quickly become the citizens and leaders of tomorrow, a tomorrow which could not be accurately predicted (Trilling & Fadel, 2009). As such, they will need a set of skills to be able to survive and thrive in the turbulent and uncertain years ahead (Zhao, 2012).

Using PBL in the classroom could help students prepare for the future (Zhao, 2012). However, due to the many versions and misconceptions of PBL (Savery, 2006), it is not a strategy teachers typically choose when developing lessons (Trilling & Fadel, 2009). This study found that a standardized framework of PBL could be a rigorous enough instructional strategy for teachers to use to meet the expected cognitive processing levels of the CCSS.

The most influential barrier to implementation of PBL identified in Henry's (2012) survey of school leaders and teacher was a "lack of professional development" ("The Barriers to PBL Implementation," para. 3). The information from this study could be used to direct professional development decisions for teachers. The framework for PBL could be broken down and developed standard by standard until teachers become comfortable with the entire process.

Once teachers are comfortable with the entire standardized framework for PBL, an extended study within the school could be conducted. This extended study could be used to evaluate the application of the standardized approach to PBL as well as its effect on student mastery of the CCSS. In order for the extended study to verify the results of this research, all of the synthesized PBL standards must be used, as they build upon each other. It also bears mentioning that the Standards of PBL only meet 100% of the criteria when they are all used in conjunction with one another.

Conclusion

The students of the 21st century have been in one of the most dynamic times in history. Everything around them changed exponentially. Yet they are still being taught in classrooms developed for the purpose of mass producing standardized and uniform citizen for the Industrial Age workplace (Trilling & Fadel, 2009).

The purpose of this study was to determine if PBL could be used as an instructional strategy in the classroom to meet the 21st century needs of students in states who have adopted the CCSS. The results of this study show that the standardized approach to PBL was cognitively rigorous enough to meet the cognitive processing demands of the CCSS and the ISTE Standards-S.

These were promising findings that may have the power to move teachers beyond their fears toward something better for their students. The students in today's classrooms will be faced with unpredictable challenges. Only through conscious development of 21st century skills, such as creativity, critical thinking, collaboration, and communication will they be able to overcome their obstacles (Boss, 2012). PBL may prove to be a strategy which can rout the challenges of today while also preparing students for the challenges of tomorrow.

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Vita

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