A SYSTEMATIC REVIEW OF THE LITERATURE: THE IMPACT OF CONSTRUCTIVIST LEARNING THROUGH AUTHENTIC PROJECT-BASED LEARNING EXPERIENCES

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by

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DEDICATION

Thank you to the most important person in my life, my husband, Eric Laur, for putting up with my crazy idea to start this degree program on a whim. Your support and love have carried me through the last four years as I tried to set an excellent example for our daughters that they can be anyone and accomplish anything that they set their mind to no matter what age they start a journey. As promised, this is my LAST degree!

To my parents, Ron and Elaine Lassinger, you encouraged my dream of attaining my doctorate from the time I was a teenager. No matter how many years have passed since I left your charge, you have and always will be my biggest cheerleaders. Thank you for setting the best example of how to be a supportive parent.

ABSTRACT

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Project-based learning (PBL), in one form or another, has been a pedagogical possibility in classrooms for over a century. The degree to which PBL is defined, planned, and executed varies immensely. This systematic review analyzed nine databases, and 747 studies were screened. The selection criteria were met by 145 studies to determine further what the existing literature states about how the design and implementation of a PBL unit of study are enhanced when it is an authentic experience. Accordingly, authentic PBL parallels how subject matter experts engage in the world outside of education. The results returned a three-themed categorization of the research that has been previously classified as authentic PBL: extended project-like activities, academic projects with limited inquiry, and authentic project-based learning experiences. The data collection showed a lack of researcher and teacher understanding of what qualifies as an authentic PBL experience and suggests quality professional development on authentic PBL is needed.

KEY WORDS: Authenticity, Constructivism, K-12, Project-based learning, Subject-matter experts

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To the rest of my committee, thank you for taking a chance on me when I was down and out and switching my dissertation focus due to a global pandemic that canceled my data collection site. Dr. Melinda Miller and Dr. Matthew Fuller, you jumped right in when I needed support, and the light at the end of the tunnel seemed too far away to reach. I appreciate your words of encouragement that mean more than you realize.

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PREFACE

This dissertation began as research focused on the impact that subject matter experts (SMEs) have on learners when those SMEs help teachers to design authentic project-based learning experiences. I was set to collect data in the summer of 2020. However, like everything else in the world during that time, COVID19 halted my work. After a few months of mourning the loss of my research that might have been, I shifted my focus to a systematic literature review that even a world pandemic could not stop. The switch was quite possibly the best pathway in my long doctoral journal. My research in this dissertation sheds light on the vast disparities that exist in how authentic project-based learning is defined and implemented.

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CHAPTER I

Introduction

Nearly four decades ago, under President Reagan, *A Nation at Risk* published compelling evidence that rigor in the classroom was necessary to ensure the United States would remain competitive on an international stage (National Commission on Excellence in Education, 1983). As a result of this report, the allocation of millions of dollars in government and private funding focused on education reform (Blivin & Mayo, 2018). Today, on the national and state levels, funding for education is a source of much discussion and debate. As the most recent numbers available for reported spending show, the U.S. Department of Education (2021) produced a budget of $762 billion in 2017-18. Since *A Nation at Risk,* department funding has supported multiple other government initiatives to give states additional freedom to set education initiatives while requiring strict reporting of school expenditures (Education Week, 2019). These initiatives include Clinton's *Goals 2000* to provide grants to reform schools at the state level, G.W. Bush's *No Child Left Behind* to hold states accountable on math and reading scores, and Obama's *Every Student Succeeds Act (ESSA)* to ensure student achievement for all learners (Education Week, 2019). However, the effects of those reforms, coupled with the spending of billions of dollars, remain in question.

At the turn of the twenty-first century, hopes were high that education spending would lead to positive results. Numerous findings proved otherwise. A 2004 study of the National Assessment of Education Progress test found coding of fourth-grade and eighth-grade math questions used whole numbers from third-grade content instead of more

complex problem-solving methods necessary for deeper problem solving (Loveless, 2004). In 2011, students of color had made minimal gains in reading and math proficiencies, with fourth-grade white students achieving a 44% proficiency rating compared to 17% of black students and 24% of Hispanic students (Birman, 2011). By 2015, despite factoring in economic differences, disparities between state testing results were evident as some states increased math and reading proficiency rates under *ESSA* by up to 40% while other states dropped in these same categories (Jacob, 2017).

These outcomes support the idea that current classroom practices have not met the goals of decades-old U.S. reforms in education. As a result, over the last ten years, a call for moving away from the teacher as the content expert who shares information has become more prevalent. As noted in EDUCAUSE's 2018 Horizon Report on the state of education, "the prioritization of active learning over rote [memorization] develops students as active contributors to the knowledge ecosystem" (Adams-Becker et al., p. 2). Muro et al. (2019) stated artificial intelligence has contributed to the decline in the need for skills related to students memorizing information. According to Henderson and Dancy (2011), survey results determined a move toward student-centered learning leads to improved student learning overall in STEM education programs. More specifically, studies from Stanford's Center for Opportunity Policy in Education revealed a student-centered approach to learning produced scholars who outperformed their peers on state assessments, graduated at greater frequencies, and had higher college completion rates (Friedlaender et al., 2014). Additionally, it is essential to note that this study included minority and economically-disadvantaged students who improved in all of the listed

categories (Friedlaender et al., 2014). These results supported calls for moving our pedagogical targets in the classroom over teaching to the standardized test.

Over the last forty years, more detailed studies at various educational levels support a shift to a more predominantly student-centric approach that seems to match our national education reform goals since the 1980s. Schoenfeld's (1996) comparative study of two courses (a research group and problem-solving course), from a quarter of a century ago, concluded the professor is not the sole authority of knowledge in the class, but rather the class is an evolution of a network of learning. Schoenfeld (1996) reported, "students [who] are engaged in legitimate explorations end up in novel territory," which leads to unexpected answers (p.16). In a one-year case study of online learning in high school, Morales, Bang, and Andre (2013) determined the student-centered approach of project-based learning (PBL) is effective with minimal teacher guidance. However, as reported in a recent Gallup (2019) poll on creativity in education systems, only 26% of learners reported spending class time involved in projects that connect with real-world applications that can lead to creative answers. In this same poll, 52% of teachers said their students engaged in real-world learning opportunities (Gallup, 2019). This discrepancy between teacher and student perceptions illustrated the need for education systems to move away from the 1990's knowledge-management systems, noted by Hagel and Brown (2017), in which the teacher shares information. However, the authenticity of a learning experience does not guarantee the "buy-in of the learner" as authenticity forms through "dynamic interactions" between the learner, the task, and the learning environment (Barab & Duffy, 2000, p. 38).

Despite these findings, the move toward more student-centered learning has come to fruition slowly as research has shown many teachers find these pedagogical shifts to be "taxing" (Mergendollar & Thomas, 2001, p.5). As most recent evidence indicated, in a modified Delphi study that surveyed and interviewed fifty PBL expert teachers, teachers who shift to a student-centered approach of teaching, such as project-based learning, need professional support in developing these student-centered habits (Grossman et al., 2019). Thus, as we begin a new decade, the pedagogical approach toward student learning continues to evolve.

Background of the Study

As we enter the third decade of the twenty-first century, our economic, political, digital, and environmental landscape changes happen at an alarmingly fast rate. Simultaneously, as evidenced in the aforementioned Gallup poll (2019), our educational infrastructure and pedagogical transformations have shifted at such a slow pace that these changes are often difficult to detect. However, in the spring of 2020, in the wake of the COVID-19 pandemic, all states had to rapidly deploy online learning models with little to no help (Sun et al., 2020). Moreover, support for the U.S. Department of Education to allow states to suspend state testing requirements, as well as the current suspension, in late 2020, by many higher education institutions on the use of standardized testing results as a requirement for college admission temporarily, may, in turn, lead to more systematic changes soon (U.S. Department of Education, 2020; NPR, 2020). While we may not realize the fallout from COVID-19's impact on educational systems fully for years to come, currently, we can analyze the attempts at pedagogical changes over the last few

decades. In turn, these analyses may demand transformations to the learning ecosystem that emerges in a post-COVID-19 world for in-person, hybrid, or virtual learning models.

As researchers call for a greater focus on improvements in teaching practice, educational "innovations" sometimes forego teacher training leading to a slower rate of adoption of these practices (Serdyukov, 2017). Survey results of over 700 physics teachers indicated teachers might want to change their instructional practices but have not fundamentally altered these practices even with the availability of new curriculums and training offerings (Dancy & Henderson, 2010). Similarly, in an earlier study, Henderson and Dancy (2007) reported instructors often blame various classroom factors, including lack of time and expectations to cover a large amount of material, that caused them to resort to more traditional instructional practices than innovative ones. However, with an average of just under fifty hours of professional development, spread out over a year, targeted professional development has increased student achievement by as much as 21% (Blunden et al., 2007). Conversely, researchers found quick teacher training sessions with little to no follow-up have no statistically significant impact on student learning (Darling-Hammond et al., 2009). The relationship between a lack of teacher training for rapid deployment of online learning and best practices for online teaching will continue to be a source of new research avenues. The anticipation that the COVID-19 educational crisis will produce previously unforeseen educational shifts for some time exists, and the research studies that come out of this crisis will impact how quickly these shifts occur.

With the shutdown of schools in the wake of the COVID-19 pandemic, teachers had to adapt rapidly to changing their teaching practices via online delivery. In a survey of teachers by the Teaching Tolerance Organization, educators were unprepared to do

more than merely transfer worksheets into online formats or prepare packets of work for pickup from schools (Collins, 2020). Collectively, these findings promote the need to alter how we approach teacher training and pedagogical implementation to incorporate lasting change in professional practice in the classroom, whether online or in person. Specifically, as many businesses were better prepared to shift to remote options for continuing operations, we must contemplate considerations for turning to the corporate world to determine alignments with the world of education.

Deloitte, in partnership with Global Business Coalition for Education, compiled a framework for action for businesses to adopt as we find ourselves in what is referenced as the Fourth Industrial Revolution, which is characterized by robotics, artificial intelligence, the Internet of things, digitalization, and automation (Armstrong et al., 2018). Worldwide companies, such as Deloitte, have called for a change to a globally underprepared future workforce, which requires youth engagement in dialogue with the business community as they lead the way to innovative solutions to this challenge (Armstrong et al., 2018). Parallel to this thinking, Thomas and Brown (2011) described a shift in our twenty-first-century infrastructure that requires educators to move beyond the use of technology as a replacement for twentieth-century pedagogy and into a space that involves innovation through connections that were difficult to make and maintain previously.

Recently, the Institute for the Future (2018), in collaboration with the Lumina Foundation, produced evidence that the artificial intelligence (AI) of the Fourth Industrial Revolution is on the cusp of interrupting social systems, including education, to the degree that may render schools as we currently know them useless. They noted the

possibility of creating a “community work + learn lab” (Institute for the Future & Lumina Foundation, 2018, p.9). However, in a review of six action research studies, Kubik (2018) boldly noted teachers, as well as students, must admit they are “unprepared for some of what they need to learn” and must begin to accept the “invitation to participation” in their learning (p.8). Now, more than ever, during the COVID-19 crisis, educators have realized they are unprepared for what they need to learn and what students need and desire to learn.

The potential to establish much of this participation in learning is possible through partnerships developed through authentic connections in the community, with businesses, and, when possible, via subject matter expert (SME) collaborations. Thus, our educational reform efforts must focus on reimagining our pedagogical practices with a specific target on developing authentic project learning experiences to solve real-world challenges. As we move beyond the confines of the school walls, the possibilities for enriched connections to one’s community and beyond better prepare our learners for success (Education Reimagined, 2015).

Statement of the Problem

Educators and politicians created the current educational system prevalent across the United States more than a century ago to meet the needs of a society and an economy that has long since evolved (Education Reimagined, 2015). Conventional schooling is often inauthentic without critical thinking opportunities and has no intrinsic value beyond students’ grades (Newmann & Wehlage, 1993). Our vast school system, both public and private, is primarily ensconced in the “preservation of the status quo” (Chen, 2010, p. 3). Encouragingly, over the last decade, we have witnessed some challenges to that which

has been the norm since the Second Industrial Revolution. Today, this "core content and basic skills" approach of rote memorization is recognized more frequently as an inferior approach to teaching and learning, while more innovative pedagogical approaches such as project-based learning (PBL) have gained traction (Education Reimagined, 2015, p.3). PBL, as a standards-driven approach to an inquiry-based challenge, is seen as a more student-centered pedagogical classroom implementation comparatively (Markham et al., 2003). Overall, however, studies related to possible innovative impacts as a result of PBL implementation have mainly been limited to student engagement in the learning process and teacher-to-student relationships (Boardman et al., 2017; Hall & Miro, 2016; Hendry et al., 2016; Neo & Neo, 2009; Suwaed & Rohaouma, 2017).

Recently, Harvard's Graduate School of Education's 2018 study discussed the impact of school designs that support a PBL approach to teaching and learning on student engagement (Business Wire, 2019). Through a series of student and faculty surveys, interviews, and formal observations, the study concluded that student motivation and confidence improved when opportunities were provided to learners to interact in a project-based environment (Harvard Graduate School of Education, 2018). Moreover, the study found that 95% of students learned better through PBL supported approaches (Harvard Graduate School of Education, 2018). Similarly, a 2009 study across six schools, using challenge-based learning, a subset of PBL that calls for teachers to guide the process of constructing knowledge, reported 95% of students found the learning experience to be worthwhile (Johnson et al., 2009). Teachers in the study noted the students were excited by the challenges they tackled (Johnson et al., 2009).

The research regarding engagement of learners through PBL spans across multiple grade levels, including high education systems. Using an adaptation of the Student Engagement Survey, researchers found that students in PBL classes exhibited higher engagement levels with course content (Ahlfeldt et al., 2005). Similarly, students enrolled in an Engineering Optional Program instead of a traditional STEM course were significantly more engaged in the PBL course (Hall & Miro, 2016).

While research often explores student engagement and the effects of PBL in the classroom, to a lesser degree, impacts on attendance and effects on test scores are also topics of study (Creghan & Adair-Creghan, 2015). However, the application of PBL in research studies varies. Furthermore, the varied research methodologies employed leave no specific overview or outcome for an argument for or against a PBL approach to teaching and learning. Simultaneously, while several prominent PBL organizations have offered definitions of PBL or required elements to meet, how these elements are applied, or their application level in project design also differs from study to study (Markham et al., 2003; PBL Works, 2019; Thomas, 2000). The offered PBL experiences in research studies are based on each researcher's review with no standard metric to vet the quality of these project experiences.

Early research in PBL called for the simulated conditions under which an expert might experience a challenge but did not include true subject matter expert (SME) interactions with students and did not explore the teacher-to-SME relationship (Blumenfeld et al., 1991). Nearly thirty years later, Svihla et al. (2019), in a longitudinal study, reported the positive impact that SMEs have on the teacher design of challenges to lead to better performance assessments rather than the SME-to-student connection

possibilities. Although Hall and Miro (2016) found that higher instructional feedback levels were not statistically significant in their attempts to enhance student learning, the study focused on instructor feedback rather than SME feedback. Conclusively, this three-decade shift in the research is positive but has yet to fully realize the vast potential for student participation in an authentic project-based learning experience.

Two major PBL literature reviews have been commissioned since 2000. The most oft-cited review, written by Thomas (2000) for the Autodesk Foundation, focused on a suggested set of design principles for PBL after noting no set criteria existed. The second literature review was completed in two phases by Condliffe et al. (2017) for Lucas Education Research of the George Lucas Foundation and focused on only those studies published after 2000. The first part of this review was broad, like Thomas' earlier review (Condliffe et al., 2017). The second part of the review began with studies starting in 2015 that were qualitative and quantitative and used a control group of learners (Condliffe et al., 2017). Importantly, these second phase studies did not include the "close cousins" of PBL (Condliffe et al., 2017, p. 3). None of these major reviews since 2000 have targeted recommendations for advancing a PBL pedagogy in a particular direction.

This systematic review of the literature identified the research that provided evidence for including a more authentic PBL learning ecosystem that uses real-world problems, community connections, and subject matter experts who interact with teachers and students during the design and implementation of a PBL experience. As such, this is an investigation beyond the typical use of an SME as a mentor or guest speaker in a classroom (Alper, 2017; Fisher, 2018; Line & Pyle, 2017). Additionally, this study reached beyond the standards set by national organizations that call for learners to merely

explain how experts work in the field and think like experts (National Council for Social Studies, 2013). Moreover, this systematic evaluation of the research sought to cull out the differences between simulated activities that mirror the real world and learning experiences that require students to solve problems in the real world.

Purpose of the Study

The purpose of this study was to determine what the existing literature states about how the design and implementation of a project-based learning unit of study are enhanced when it is an authentic experience.

Significance of the Study

Entrepreneurs or innovative thinkers who problem-solve authentic challenges typically have one thing in common: they are successful, not due to their school but rather "despite" their education (Zhao, 2012, p. 7). Today, our world changes at a fast pace that increases each year incrementally. From government to the economy and education, the systems currently in place struggle to maintain a rate of change that accelerates as quickly as it must in response to learners' needs. Thus, our education system is ripe for individuals who are ready to solve today's challenges to prepare us for a world of tomorrow. However, the pace at which most schools are prepared to change is arguable. As evidenced in the spring of 2020 with the need to switch to online instruction across the U.S. and much of the world almost overnight, schools were unprepared for the unprecedented demand to shutter school doors (Garcia & Weiss, 2020). This phenomenon is what Resnick (1987) referred to as "'breakdowns' that render the normal, routine way of doing things inadequate" (p. 17-18).

However, the emergent need to develop online and remote learning plans only illustrates a brief glimpse into the lack of educational change learners experience. In a concept paper released by the Canadian Education Association over a decade ago, Dunleavy and Milton (2009) reported that high school students want a) an ideal school in which they b) learn from others in their community and c) connect with experts with more opportunities for d) dialogue and conversation as they e) solve real problems that can f) make a difference in the world. While the report did not divulge how many students they interviewed versus surveyed, a pertinent piece of information when appraising the findings, additional studies on engagement produced similar outcomes (Arnold & Mihut, 2020; Holthuis et al., 2018; Taylor & Parsons, 2011). Specifically, Almulla (2020) found that engagement in learning improved in 77% of students involved in an authentic project learning experience. Almulla's (2020) use of structural equation modeling noted a significant relationship between PBL and authentic learning in producing more engaged learners.

Fisher and Fisher (2018) boldly declared that while schools investigate every aspect of what students know and do not know, they failed to determine whom students know, which results in a "critical blind spot in education" (p.3). The duo insisted it is time to reimagine our schools as "networking hubs" (Fisher & Fisher, 2018, p.11). This re-imagination is in line with the collaborative predictions from the Institute for the Future (2018) and the Lumina Foundation that anticipated "learning to learn" will be one of the most widely needed skills for the future (p.13). Project-based learning's constructivist approach to pedagogy lends itself to a "learning to learn" set of skills that

can flourish in networking hubs and, therefore, is examined as a foundation for this review.

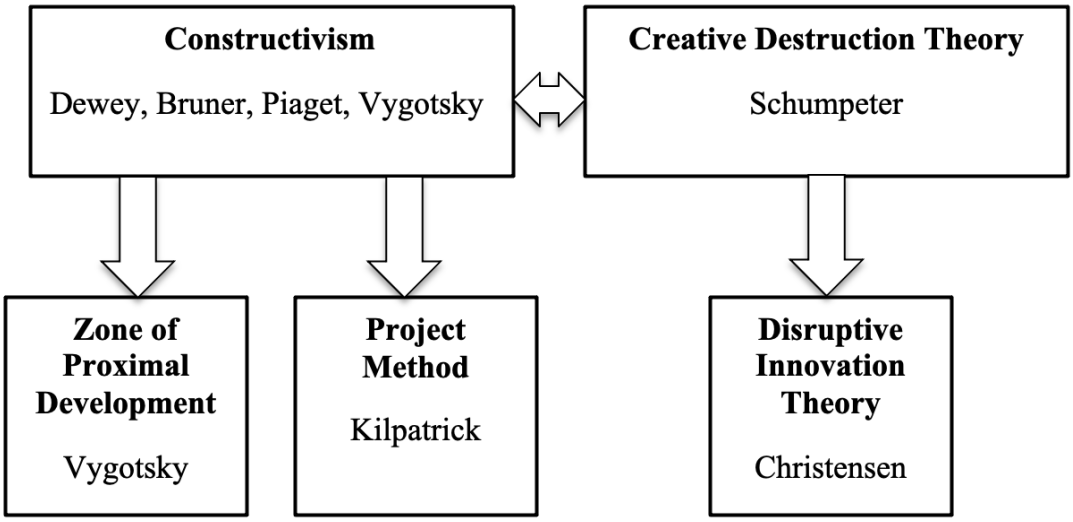
This study's findings intend to support further the need for a shift in pedagogical teaching practices toward a more authentic PBL approach to teaching and learning in a work-to-learn ecosystem rather than a learn-to-work environment. Historically, teachers' and researchers' understandings of project-based learning impact the level of authenticity in the learning experience developed. With this systematic review of the literature, determinations for future research and suggestions for shifts in current instructional practice are possible.

Theoretical Framework

The foundations of this study are rooted in several intertwining pedagogical theories developed in the early twentieth century. Two newer and less-frequently found theories in educational literature are also included in the theoretical framework. Each theory builds upon the other to provide a roadmap to how an authentic approach to PBL enhances the unit's design, implementation, and feedback process. Figure 1 illustrates the connection between the theories applied in this study. Simultaneously, the included text briefly describes each theory's importance and its link to how authentic experiences enhance a PBL unit's value.

Figure 1

The Connection Between Theoretical Frameworks



Constructivism

Constructivism, as a widely adopted sociological and pedagogical theory, developed throughout the twentieth century (Adams, 2006). The various constructivism influencers include Dewey, Bruner, Piaget, and Vygotsky (Adams, 2006). Today, constructivism is known as more of an umbrella term that encompasses a variety of pedagogical approaches. Although, Lebow (1993) asserted constructivism is a philosophy of teaching rather than a method of teaching. Generally, however, it is agreed upon that constructivism requires a dynamic ability to construct one's knowledge rather than passive consumption of knowledge that is shared by another (Adams, 2006; Duffy & Cunningham, 1996). Using what students already know and what students must learn, teachers can apply constructivism to ensure the application of that knowledge (Amineh &

Asl, 2015). Moreover, that application becomes more meaningful when contextualized as students working in an experience that is authentic rather than simulated.

Vygotsky's work as a constructivist in the early twentieth century noted testing simply indicated what students had learned up to a certain point rather than what students had the potential to learn (Shabani et al., 2010). Vygotsky (1978) defined this phenomenon as the *zone of proximal development* (ZPD) in which he noted students have an actual development level of problem-solving and a potential level of problem-solving which is influenced by "adult guidance" or a "more capable peer" (p.86). Through working with adult guidance or the more capable peer on one problem, the next time a student attacks a similar situation, the ZPD will increase (Shabani et al., 2010). Based on this notion, the use of SMEs in an authentic PBL unit to provide value-added feedback as a student develops various possible solutions to the given authentic project learning experience can improve the problem-solving process.

The Project Method

In the early twentieth century, Kilpatrick introduced the Project Method in which he emphasized student motivation with little teacher guidance (Morales et al., 2013). While adopting a PBL framework does not mean that teachers allow students to guide their inquiry with no support, one could infer the need for advice outside of the teacher's presence, much as one would find with a community or business connection that utilized an SME. Moreover, Kilpatrick's Project Method advocated for implementing a project with a purpose, one which would not merely prepare students for their future lives but instead was considered part of their lives (Pecore, 2015). Here, the importance of ensuring learning moves beyond the textbook memorization and standardized test

preparation often found in educational systems is paramount. Ideally, the implementation of authentic learning experiences led by SMEs and relevance to students' lives reflects Kilpatrick's Project Method.

Creative Destruction Theory

Grant (2017) advocated promoting originality by destroying old systems but recognized many feared pushback potentials. With the abundant criticisms in education today, there is an environment ready for what Schumpeter, in the 1940s, coined as creative destruction theory (Reier, 2000). Initially, an economic theory, creative destruction preys on situations that are ripe for innovation (Reier, 2000). However, due to the COVID-19 crisis, the spring of 2020 experienced the most significant destruction of educational systems since the Progressive Era more than a century ago (Garcia & Weiss, 2020). While speculation on the educational outcomes of the pandemic abounds, we know that educational systems will change forever due to the near-overnight shutdown of schools across the United States and much of the world.

While COVID-19 caught educational systems underprepared for shifting to online learning, creative destruction also applies to a longer-standing need in how we approach college and career readiness. According to the United Nations (2020), "this [COVID-19] crisis has stimulated innovation within the education sector" (p. 2). We are on the cusp of what will be known as the Fourth Industrial Revolution, compounded by the COVID-19 pandemic's work from home orders, in which new skill sets will transform the workplace for jobs that already exist and ones that will begin to replace the careers that become obsolete (World Economic Forum, 2018). Specifically, the World Economic Forum (2020) has identified a series of critical characteristics, including

innovation, project-based learning, and lifelong learning, necessary for education models in the Fourth Industrial Revolution. As such, the World Economic Forum (2020) calls for "interactive methods [of teaching] that promote the critical and individual thinking needed in today's innovation-driven economy" (p. 5). Thus, while "nothing is completely original," we need to move beyond finding "surface ways to appear original" (Grant, 2017, p.3; p.13). Through the creative destruction theory, educators and learners today have the power to transform the learning experience into an authentic one that connects learners to their community and one that leverages the expertise of SMEs to prepare our students for a future world that has yet to be defined.

Disruptive Innovation Theory

With its introduction in the mid-nineties, the disruptive innovation theory developed to explain how smaller, less established businesses with few resources can take on much larger entities (Christensen et al., 2015). Accordingly, the theory has a primary application to the business world; think Airbnb versus any corporate hotel chain. Expressly, disruptive innovation theory purports the development of simple solutions that allow for those that have not had access to resources or capital to disrupt existing markets previously (Christensen, 2018). The most widely known theorist of disruptive innovation, recently deceased Harvard professor Clayton Christensen (2018), noted one of the most potent disruptive innovation opportunities within our schools is connecting our students with those outside of the school system. These connections are especially critical to those that have previously been unconnected due to geographic or economic gaps (Christensen, 2018). To this end, we see a need for authentic community connections as a new network of opportunities.

Research Question

The following question guided this study:

1. How does the systematic literature review process inform the constructivist pedagogical approach to teaching and learning through authentic project-based learning?

Definition of Terms

The following terms are related to this study:

Authentic (Authenticity). Cognitive challenges that experts would face in the real world outside of the classroom (Honebein et al., 1993).

Bloom's Taxonomy. The hierarchical categorization of active learning, as an individual makes sense of their knowledge, which portrays the level of deep learning happening (Anderson et al., 2001). The six categories of learning range from the lowest end of cognitive processing at "knowledge" to the highest level of cognitive processing at "creation" (Adams, 2015).

Constructivism. The act of making one's knowledge through active participation in the learning experience once added to the existing schema. (Travers et al., 1993).

Project-Based Learning (PBL). An extended instance of learning that promotes inquiry in a standards-driven approach to a problem with the required tasks (Markham et al., 2003). Project-based learning is sometimes and more recently shortened in the literature to PjBL. However, from the review of the literature, the vast majority of references utilize PBL.

Inquiry Learning. A pedagogical approach in which students engage in asking questions to construct knowledge (Keselman, 2003).

Subject Matter Expert (SME). An individual who works in a particular field of study, outside of the classroom, which "focuses on the real-life application of information and helps learners think about content from an enterprise-wide perspective," is considered to be an expert in that field (Ludwig & Owen-Boger, 2018, p.4).

Delimitations

The systematic literature review did not focus on one primary sector of education. This review encompassed all three school levels rather than exploring only elementary, middle, or high school. The inclusion of these three education levels was chosen to provide a more comprehensive approach to understanding the research question's outcome.

Limitations

While the systematic literature review is broad in that it included all three levels of education, a focus on one of the three may have produced an even more detailed review at one level. Additionally, university-level experiences were not included in this review. After the initial returns of database studies revealed an abundance of university-level engineering and medical school-related studies, it was determined that these studies might skew the results of the review rather than provide a more comprehensive investigation.

The researcher acknowledged her personal preference for using an authentic project-based learning experience pedagogical approach to teaching. Furthermore, the researcher admits her professional work in conducting teacher training that connects educators with community partners and subject matter experts. These preferences of the

researcher influenced the creation of the keyword and selection criteria for reviewing the literature.

The researcher recognized the overall lack of literature related to project-based learning that included a subject matter expert in the project's design and execution. This recognition led to the desire to investigate the existing research on PBL and categorize the definitions and applications. Additionally, while the lack of specific literature may have hampered the study, it also provided a need for the review itself. Ultimately, new directions for future research are expected as a result.

Assumptions

The researcher assumed there are far more instances of possible community connections and potential uses of SMEs as co-designers and co-facilitators of authentic project-based learning experiences than occur presently. However, those assumptions factored into the literature's systematic review by providing evidence for community connections and possible inclusion of SMEs in future designs and implementations of authentic PBL experiences. Moreover, the researcher assumed that teachers often do not design and implement authentic PBL opportunities with community partners or SMEs because of a lack of professional development training. Again, this review intends to provide evidence for the need for such training and support.

Organization of the Study

Chapter One of this study set the foundation for the need for a systematic review of the literature related to authentic project-based learning. A lack of systematic reviews in the last twenty years created a need for this current review. More so, a focus on how

PBL and authenticity are defined in existing research are intended to develop future research directions on authentic project-based learning experiences.

The remainder of the study reviews, in detail, the literature of previous works to determine the foundational components for the design and implementation of an authentic PBL experience to increase the impact of a constructivist pedagogical approach to teaching and learning. The literature review for Chapter Two first delves into the pedagogical approach of PBL and is followed by the link between PBL and authenticity. The literature review continues with an investigation into the theories applied to this study.

Chapter Three provides the systematic review's conducted steps and includes the analyses of the systematic review process. Chapter Four describes the analysis of the results of the systematic literature review related to the themes explored during the review. Finally, Chapter Five advances the conclusions determined through the systematic review and considers future directions for further research, as evidenced by the systematic literature review.

CHAPTER II

Review of the Literature

Introduction

In a recent *Collaborative for Academic Social and Emotional Learning (CASEL)* study, 48% of surveyed young adults reflected on their high school experience as one that prepared them for success outside of academia, and only 41% felt ready for a career (DePaoli et al., 2018). Findings from a 2016 Gallup poll suggest a more dire situation at the high school level, with only 32% of high school students who noted they were engaged in the learning process (Calderon, 2017). Gallup's survey outcomes represent 3,000 schools a year, and since 2009, when their Student Polls was launched, they have consistently found that engagement decreases from elementary school to high school (Calderon, 2017). With a decrease in engagement comes an increase in negative teen attitudes toward school. Findings from Yale's Center for Emotional Intelligence and Child Study Center revealed 75% of the 2,000 teens from across the U.S. who participated in an open-response survey provided negative answers with the top three responses as tired, stressed, and bored (Moeller et al., 2020).

Ewing Marion Kauffman Foundation (2019), in a nationwide survey of 2,000 participants, indicated that views of real-world preparation of high school graduates have gradually declined from a high of 70% in the 1950s to 49% of respondents who believe high school graduates are only "somewhat" prepared today. In comparison, school systems that have adopted a constructivist learning approach reported different results. The recent longitudinal study of six Big Picture Learning schools and 1,900 students determined a deep connection between students and adults through their Learning

Through Internship (LTI) program (Arnold & Mihut, 2020). All Big Picture Learning graduates must participate in the LTI, with this participation reported as the top or second most crucial element of their high school career in preparing them for the future (Arnold & Mihut, 2020). These results suggest that transfers in pedagogical approaches to teaching and learning are overdue.

The pedagogical shift that has received the most attention for its promise to overhaul the way educators teach and students learn is project-based learning or PBL (Schneider, 2018). Far from a new methodology, modern-day PBL traces its roots to over 100 years ago and The Project Method under Kilpatrick (Schneider, 2018). However, as Kilpatrick (1918) cautioned readers over a century ago, there are two primary questions to answer before becoming enamored with the idea of a potential classroom-altering pedagogy: Is the concept of project learning worthwhile to explore, and does the term "project" fit the description of the methodology appropriately? The last one hundred years have shown that the Project Method, and the PBL movement that has grown out of it, have gained traction slowly. However, Kilpatrick's Project Method ideas have been revised significantly through the PBL lens (Condliffe et al., 2017). As of 2021, the High-Quality PBL organization, sponsored by the Hewlett Foundation, had over 3,000 member schools (Schneider, 2018). In comparison, PBL Works reported training more than 50,000 teachers in 2016.

Authentic Project-Based Learning and Related Constructivist Pedagogies

PBL "should be authentic or realistic" (Jumaat et al., 2017, p. 7904). The connection of learning objectives to real-world tasks leads to a constructivist view that allows students to create their understandings (Roach et al., 2017). Real-life problems are

more engaging and complex (Savery & Duffy, 1995). These real-life problems are in contrast to well-structured scenarios often posed in a classroom setting. “Well-structured problems do not grow or change, unlike the problems faced in daily life. In contrast, ill-structured problems often take on a life of their own” (Mergendoller et al., 2006, p.16). However, not all project-based learning (PBL) experiences are created equally. In their study of self-reported student perceptions of authentic experiences, Roach et al. (2017) noted, “while there is much overlap between authentic learning and PBL, not all forms of PBL are authentic” (p. 497).

“Authentic environments [are ones] that correspond to the real world” (Pataglia, 1998, p. 53). However, “authenticity is objective” (Pataglia, 1998, p. 59). When alignment between learning objectives, content, context, and real-world tasks occurs, authenticity is inherent (Roach et al., 2017). Brown et al. (1989) noted situated learning happens in an authentic context. As such, Herrington and Herrington (2008) called for authenticity as a curricular design model versus a learning theory. The “parallel tracks” that authenticity and PBL run on make it difficult to separate the curricular design process from the pedagogical practice. (Roach et al., 2017, p. 496).

Roach et al. (2017) suggested a need to create more opportunities for all students to apply their technical knowledge through practical application (p. 495). However, two decades before, Hiebert et al. (1996) noted a need in curriculum and instruction reform to “allow students to problematize the subject” (p.12). “Rather than mastering skills and applying them, students should be engaged in resolving them” (Hiebert et al., 1996, p.12). Here, using a project as the “central vehicle of instruction with students as the active participants in the construction of knowledge” is preferable (Condliffe et al., 2017,

p. iii). As noted by Thomas' (2000) review of the PBL literature, the definition of how this central vehicle is put into practice is contested among researchers.

Jonessen and Hung (2008) noted "the diverse use of the term PBL to describe a variety of learning activities that often bear little resemblance to each other" could create confusion in its application (p. 22). "The lack of uniform vision complicates efforts to determine whether PBL is being implemented with fidelity and to evaluate its effects" (Condliffe et al., 2017, p. iii). While PBL has been around in one form or another, for decades, from the constructivist theory approaches of Piaget, Vygotsky, and Dewey (Vadeboncoeur, 1997) to Kilpatrick's Project Method of the early 1900s (Pecore, 2015), PBL has evolved in its meaning and implementation.

PBL implementation spans in application from various constructivist approaches and includes a range of structures and content selection processes (Mergendoller, Markham, Ravitz, & Larmer, 2006). Steeped in constructivist underpinnings, a generally acknowledged, albeit loose, definition of PBL is an extended instance of learning that promotes inquiry in a standards-driven approach to an authentic problem with required tasks and products (Markham et al., 2003). This definition applies to a variety of learning activities. However, these learning activities do not necessarily equate with deeper levels of thinking, nor do they always require students to engage in authentic, relevant, and complex challenges connected to the community (Petraglia, 1998; Roach et al., 2017). Moreover, teacher-created activities inherently diminish the authentic context of a learning experience (Barab et al., 2000). This "pre-authentication" or "attempt to make learning materials correspond to the real world before the learner's interaction with them" takes away some of the tenets of a constructivist learning theory (Pataglia, 1998, p. 53).

Here, the lack of fidelity to PBL implementation often arises from the disagreement on authentic learning in practice. While projects are the modality of choice for implementing PBL, the criterion for what should be included in these projects is debated.

Over a decade ago, researchers indicated the need for a common language of PBL elements that did not exist at the time (David, 2008). However, by the end of the first decade of the twenty-first century, organizations such as the Buck Institute for Education (now PBL Works) had developed a list of essential elements of PBL (PBL Works, 2019) that included inquiry and authenticity. These essential elements have undergone multiple revisions over the last two decades. The number of elements has vacillated between seven and eight, with the elements themselves changing, disappearing, and reappearing through the revisions (Mergendoller & Larmer, 2015). Despite having a checklist of elements, teachers who indicated they use projects in their classrooms regularly do not implement them to the definition's fidelity (Ravitz et al., 2000). It is also the case that teachers may implement the projects after teaching has occurred (Markham et al., 2003). A review of the literature revealed that much of the absence of fidelity to a PBL definition comes from a lack of agreed-upon characterizations within the given possible elements of PBL, most notably authenticity. However, the three values of authentic learning combined, noted by Newmann et al. (1996), bring PBL to a closer evolution of a classroom that mirrors the world outside of school.

"Construction of knowledge, disciplined inquiry, and value beyond school," while not explicitly describing PBL, provides a more in-depth explanation of authenticity (Newmann et al., 1996, p. 282). Construction of knowledge links to doing as a form of

learning. “Doing involves interacting with the real world, and such interactions are filled with changing circumstances that we cannot control (Heibert et al., 1996, p. 14).

Pataglia (1998) was concerned with the connection between constructivism and authenticity. “Constructivism gives us no reason to believe we can predetermine the correspondence of academic tasks to the real world, for that world is constantly being shaped by learners working within their own experiences and constructed realities” (Pataglia, 1998, p. 60). Instead, Pataglia (1998) insisted the question educators should ask is “how are learners persuaded that they are participating in authentic learning environments?” (p. 60). Furthermore, even if an open-ended project with authentic qualities happens in a school setting only, a disconnect exists between the content and the real world (Barab & Landa, 1997; Brown et al., 1989). Moreover, while Mergendoller, Markham et al. (2006) noted a teacher might “desire to engage students in authentic learning about real-world issues,” there was no mention of working with a subject matter expert to bring real-world context to the project planning process (p.14).

In the 90s, Newmann’s authenticity work created the path that brought PBL to the forefront in the early 2000s. Newmann and Wehlage (1993) developed conditions for authentic learning activities, including higher-order thinking, depth of knowledge, connectedness to the world outside of the classroom, substantive conversations, and support for student learning. Authentic learning activities, although not necessarily defined as PBL, must have the following components according to Reeves et al. (2002): real-world relevance, and ill-defined problem structure, complex tasks sustained over a period of time, multiple perspectives, collaborative interactions, reflection on choices made, integrated content areas, assessment throughout the activity, authentic products,

and diverse possible outcomes. Authenticity, however, is not placed "in the learner, the task, or the environment, but in the dynamic interactions among these various components" (Barab et al., 2000, p. 38).

A much lesser-known authentic learning approach was formulated about a decade before Newmann's work in the 1990s. Gordon's (1998) early developments at Antioch University, in Education by Design/Essential Skills, included a sliding scale of authentically designed challenges for learners. "Academic challenges," which take curricular contexts and turn them into structured problems, are considered by Gordan (1998) as an entry point into authentic learning. Once a teacher and student have mastered an academic challenge, a "scenario challenge" allows students to take on a real-life role in a fictionalized context (Gordan, 1998). Finally, a "real-life problem" links the content to the world outside of the classroom in which learners have the opportunity to "take action on an issue and have a tangible impact on their community" (Gordan, 1998, para. 20).

In their work for the Buck Institute for Education (BIE), Markham et al. (2003) adapted Steinberg's 1997 work regarding authentic learning resulting in the Six A's rubric to assess PBL implementation. Authenticity was at the forefront of the planning elements with academic rigor, applied learning, active exploration, adult connections, and assessment practices (Markham et al., 2003). According to the rubric, for a PBL challenge to be authentic, the learning experience had to link to work which adults might undertake in the real world while simultaneously having meaning to those students engaged in the problem (Markham et al., 2003). Finally, while not explicitly defined, an

external audience to review the student work completed the authenticity category (Markham et al., 2003).

Thomas' (2000) review of PBL literature set the stage for the most premier work in PBL in the subsequent two decades. Although David Ross (personal communication, June 3, 2020), former Director of Professional Development at BIE, noted that the Autodesk Foundation commissioned Thomas' literature review. The Autodesk Foundation was a close neighbor of BIE, with former executive directors John Mergendoller and Bob Pearlman, from BIE and the Autodesk Foundation, respectively, as friends at the time of its publication. Today, Bob Pearlman still stands as an ardent supporter of PBL, and BIE (now PBL Works) continues to use the Thomas review as the foundation for their essential elements of PBL even through the various changes to the model over the last two decades.

In his review, Thomas (2000) captured five distinguishing features of PBL: centrally embedded in the curriculum, inclusion of a driving question or problem about the curriculum, requirement of an investigation into the curricular concepts, allowance for student-driven approaches rather than teacher-scripted ideals, and a real-world rather than a simulated or textbook focus. Inquiry and authenticity, the core commonalities between Newmann and Thomas's reviews, are also elements cited by PBL Works (2019) as part of their Gold Standard of PBL and are essential to the design of a PBL experience.

With references to inquiry and authenticity as a mirror of the non-academic world, one might expect a description of learning to include the use of community partners or subject matter experts (SMEs). Pataglia (1998) noted, "apprenticeship is

linked to the goal of authentic learning in that it is the natural learner-tutor arrangement" (p. 55). However, other than the Svihla et al. (2019) reference that "consultants, experts, and or teams representing external organizations" must design "assessments of learning," the initial and cursory review of the literature did not reveal the requirement of SME collaboration in the context of a PBL experience (p. 3). If anything, there were more instances of requests for students to mirror real-world SMEs through simulations or applications of the work SMEs might conduct. In fact, Collins et al. (1991) advocated for students to learn the SMEs' work before any interaction between SMEs and students happens, in the form of feedback, as they practice the skills required to become an expert. This advice is counterintuitive to the call by Markham et al. (2003) that projects must not take place after the teaching has occurred.

Markham, Larmer, and Ravitz, as employees, had direct ties with BIE in the early 2000s, as did Mergendoller and Thomas (2001). While the gentlemen in question advocated for project-based learning rather than projects after teaching a unit, specifically, in a study by Mergendoller and Thomas (2001), the duo identified principles that exemplary teachers use for implementing and managing PBL to include the need to "contract with experts to help with technology" (p. 29). However, this call to action assumed teachers only need support on technical issues and ignored any possible deficiencies in understanding core content. Mergendoller and Thomas (2001) did advocate for allowing learners to experience frustration and grapple with challenges in the classroom. In this instance, the duo noted that experts could provide the answers (Mergendoller & Thomas, 2001). Moreover, this sentiment treats SMEs as only low-level content knowledge providers rather than higher-level evaluators of project solutions.

In addition to PBL, several other constructivist pedagogical approaches attempt to expose learners to the link between studied content and a real-world context. However, there is no requirement to create an overt connection between the SME and the project, exercise, or activity in these pedagogical practices. Neither is there any requirement to go beyond a simulation of the real-world occurrence. Although, these constructivist learning methods do situate in Ross' (2018) investigation of multiple inquiry-based frameworks, which support the connections with authenticity, community partners, and SME interactions.

Specifically, problem-based learning (PrBL) aligns with PBL, which asks students to apply course content to solve authentic challenges in a simulated context such as a medical school patient case study (Jonessen & Hung, 2008). In fact, in the 1980s, PrBL began in medical school classrooms in which students solved a patient diagnostic problem (Thomas, 2000). These case studies are led by the professor acting as a coach as hypotheses were tested and offered (Thomas, 2000). Since its inception in medical schools, PrBL has been applied to law, business, and more recently in STEM and social studies courses in K-12 education (Williams, 1992; Stepien & Gallagher, 1993). Often, in these cases, the classroom instructor is considered to have enough expertise to forgo the invitation of an outside SME for collaboration with students such as medical school professors who also practice medicine in addition to teaching (Steinman et al., 2009).

Without an instructor as an expert, such as one finds in medical, law, or career technical education classrooms, teacher expertise is often limited (Steinman et al, 2009). In a review of multiple case studies on instructional design, Miller and Grooms (2018) concluded that without a client mentor, students are often unprepared to tackle challenges

that occurred during an authentic learning experience and concluded teachers could maximize learning opportunities for students when client mentors are involved in providing feedback.

Like PrBL, situated learning, as a reflection of the real world translated into the classroom, aligns with PBL. As an instructional strategy, situated learning has the opportunity to connect to what Resnick (1987) called "bridging apprenticeships" as a link between the classroom ecosystem and the workplace environment (p.17). However, Herrington and Oliver (2000) criticized the notion of situated learning as a traditional apprenticeship limited to observation rather than participation. The duo further posited the need for "authentic contexts" that included "access to expert performances" with "multiple perspectives" (Herrington & Oliver, 2000, p. 4). Moreover, much of the implementation of situated learning is limited to classroom situations rather than real-world applications. Here, Tripp (1993) cautioned that the lack of exposure to SMEs hindered learning by devaluing the expertise that these individuals provide over classroom teachers. Thus, situated learning could increase in authenticity with the introduction of SMEs.

The vast majority of these constructivist pedagogical approaches that include PBL, PrBL, situated learning, and authentic learning fall under inquiry learning methods. Schwab (1960) first brought inquiry learning to the attention of scientists and science educators when he proposed two types of inquiry learning: 'stable' and 'fluid.' Stable inquiry asks learners/researchers to fill in the blanks through questioning while fluid inquiry poises learners/researchers to create new concepts through the questions they

explore (Schwab, 1960). In either case, students must generate their queries as they gather evidence and propose explanations (Schwab, 1960).

To become proficient in the inquiry process, Blumenfeld et al. (1991) alerted educators to the need for classroom situations to mirror those situations in which SMEs are involved. There was no specific mention of the requirement to use actual SMEs as facilitators and coaches in the inquiry process. As an extension of the aforementioned pedagogical types, Ross (2019) further included design thinking pedagogies, discovery learning, challenge-based learning, and phenomenon-based learning as established on the foundations of inquiry models.

As a classroom practice, design thinking aligns with PBL, PrBL, and others since it falls in the category of inquiry learning. Specifically, design thinking is an iterative process in which learners create prototyped solutions for a challenge as they consider the end-users by refining their models (Razzouk & Shute, 2012). In fact, Suwa et al. (2000) determined that as learners as designers develop solutions for a challenge, the act of designing leads them to discover evolving iterations of that solution, resulting in better solutions.

Design thinking does show differences between experts and novices in the content at the foundation of the challenge. Numerous studies indicated that novices spend more time defining the challenge than attacking the problem from a solution-oriented approach (Liu, 1996; Gunther & Ehrlenspiel, 1999; Nigel, 2004). While these researchers defined an expert as one who has more experience in the content area studied, rather than specifically as an SME by the definition of this systematic literature review, one can posit the act of introducing an SME into an authentic project-based learning challenge would

support the more novice learners in developing an increasingly complex solution. Findings from Razzouk and Shute (2012) support this idea, as the pair noted, "designers with specific experiences related to the problem type approached the design task through solution assumptions/conjectures instead of problem analysis" (pp. 340-341).

No matter what assigned constructivist label defines the learning approach, the constructs that students use to make meaning of the content presented intend to improve the learning (Newmann et al., 1996). Over the last two decades, PBL has received more attention than the other inquiry-based models. In fact, Perrenet et al. (2000) noted the projects in PBL are aligned more closely to the professional world through less structure than other student-directed pedagogies. In contrast, "when authentic activities are transferred to the classroom, their context is inevitably transmuted; they become part of the school culture and classroom tasks and have little bearing elsewhere" (Brown et al., 1989, p.32). This contrast of the real world outside of the classroom and "authentic" tasks inside of the classroom leave room for pedagogical improvements.

More recently, in an attempt to differentiate between mere activities (similar to PrBL) and more in-depth learning, Zhao (2012) proposed three types of PBL: academic, mixed, and entrepreneurial. The former focuses on specific content and skills determined and evaluated by the teacher's design, while the latter emphasizes a final product meant to solve a challenge for an external audience of consumers (Zhao, 2012). Vaz (2019) did not specifically discuss an entrepreneurial facet to PBL but recognized the need for PBL as a "high-impact practice" that includes interdisciplinary curricular development with a "range of stakeholders' perspectives" (para. 6). Entrepreneurial PBL is the most consistent with Newmann, et al's. (1996) authentic learning definition that required a

value-beyond school. However, by description, the trio did not aspire for learners to always work fully to solve a real problem. Instead, a simulated experience was an accepted option (Newmann et al., 1996).

An entrepreneurship approach to PBL advocates learning by doing as an immersive experience (Tan & Ng, 2006). Moreover, entrepreneurship is supported by creativity, imagination, and, most notably, collaboration (Zhao, 2012). This entrepreneurship aligns with Salkowitz's (2010) proposed strategies to engage learners in a bottom-up rather than a top-down view of entrepreneurship that included partnerships between educational institutions and local businesses and leveraging local experts in the market. Thus, the student-to-community partner relationship can be symbiotic in which the student learns from the expertise of the SME and the feedback provided. Simultaneously, the SME may determine how to attack challenges from a different perspective as supplied by the student. This symbiotic relationship aligns with a portion of the role teachers play in a competency-based system that calls for a community connector that facilitates and communicates with industry partners who are stakeholders in the educational process (Casey, 2018).

In addition to these PBL approaches posited by individual researchers, several institutions have emerged with their ideas on authentic project-based learning. America Succeeds, an organization dedicated to ensuring the public education system in the United States is prepared to develop learners into future-ready workers for our global economy, declared the new *Age of Agility* requires learners who apply higher-order thinking skills to solve challenges in "diverse environments… and [are] open to a future far more fluid than that to which we are accustomed (Gaulden & Gottlieb, 2017, p. 5).

This fluidity of application is a hallmark of a true PBL experience. Similarly, in recommendations formulated between the partnership between Deloitte and Global Business Coalition for Education, a call was made for expanding the foundational skills of literacy and numeracy for our students into the following categories: workforce readiness, soft skills, technical skills, and entrepreneurship (Armstrong et al., 2018). Furthermore, the partnership between the two global organizations noted the teaching and training methodologies needed to impart these skills include project-based learning (Armstrong et al., 2018). Here, we see an alignment between the pedagogical PBL approach and the skill set of becoming an entrepreneur.

Zhao's (2012) entrepreneurial approach to PBL is far less likely to be found in classrooms. However, competency-based education models, which require meaningful assessments linked to the creation of knowledge, now call for innovation "with focused experimentation and learning" (Casey, 2018, p.26). Aligned with this idea of experimentation, we find performance assessments that are an alternative to more traditional assessment formats. These performance assessments occur when students focus on the assessment *of* learning rather than assessment *as* learning or assessment *for* learning (Earl, 2012). Furthermore, Svihla et al. (2019) reminded us that performance assessment in an authentic and complex approach to learning must demonstrate a clear understanding of the content and skills in such a way that learners see the inherent importance of the work beyond the school's walls as they receive "formative feedback from experts in and outside of school" (p. 3). While performance assessment gained favor in the late 1980s and early 1990s, by 2009, most performance assessments, as a means to determine student achievement, had largely disappeared from the K-12 education

movement (Stecher, 2010). Stecher (2010) attributed a partial downfall of the movement to the lack of validity in teachers' performance assessments as the need for true expert judgment outweighed the assessment process's implications.

Casey (2018) advocated for "educators [to] tap into the cultural and social assets of the local community and communities beyond to ground learning in students' realities and to expose them to valuable social and cultural capital" (p. 28). Additionally, over two decades ago, Jonassen (1999) called for the need for teachers' social and contextual support, even though he did not mention learners' support. This suggestion of partnering with a community's social capital would help address the deficit, noted by Deloitte's surveys, in which 31% of youth expressed their lack of relationships with adults as a barrier to their readiness to enter the workforce (Armstrong et al., 2018). Additionally, Casey's plea for a connection to social capital would also help fill the K-12 education void that does not expose learners to diverse education settings with various industry partners addressed by Gaulden & Gottlieb (2017). However, we find the recorded use of SMEs in a PBL experience is few and far between.

SME Program Implementation

According to Jonassen (1999), constructivist learning environments require SME support for teachers socially and contextually. Instances of single schools throughout the United States, a few international education institutions, as well as several summer programs, have tried to push into Zhao's (2012) entrepreneurial PBL space and connect teachers and learners to SMEs. The Bank of America CTE Summer Scholars program, offered by the New York City Department of Education, allows low-income students to earn an internship spot in the employment field of their choice while simultaneously

participating in a classroom challenge designed to increase students' college and career readiness skills as they determine how to increase youth employment in NYC ("NYC CTE Work-Based Learning," 2020). As reflected by one student participant, "... the CTE Summer Scholars Program showed me how to be more prepared when it comes to finding a job and creating new experiences. What I loved about the program was having a mentor from businesses that are well known [who] give us advice on how to improve our final project." (S. Mendelsohn, personal communication, May 24, 2016).

Moving into the Midwest area, futurePREP'd took a similar approach to connect learners to SMEs in a summer program. FuturePREP'd, during the school year, establishes business partnerships that will work with teachers and students during a two-week intensive summer program. While students spend less time in an internship capacity, teachers work with SMEs before the summer program to develop authentic challenges for their students to tackle during the two-week session. The students receive feedback from the SMEs at each stage of the challenge (N. Gitler, personal communication, August 28, 2019).

In the case study review of their Wildlands School, Tweed and Seubert (2015) categorized PBL as teacher-led, guided, or independent, with the level of teacher control changing at each of these three levels. Dintersmith (2018) spent a yearlong journey traversing the nation, searching for such schools and reviewed fifty of them that qualified, in his opinion, as innovative. While neither of these publications indicated an SME connection to entrepreneurial PBL, one would expect the alignment with the use of SMEs in the classroom. This outcome is similar to the findings of researchers who have

called for learners to develop the skills and necessary understandings of what it takes for an expert to create a final product (Lee et al., 2015).

In a comparative study of two high school economic classroom approaches, either PBL or direct instruction, it was determined there was a positive impact on student achievement in some of the PBL classrooms, while in others there was not (Maxwell et al., 2005). Maxwell et al. (2005) concluded that this outcome could be due to the teachers' training or lack thereof in the PBL methodology. However, one could argue that SMEs' introduction as support for the economics projects may have produced a different outcome.

Alper (2017) detailed how to pair a mentor from the community with students in what she has trademarked as "project-based mentoring." After a careful review of her formulas, guides, and checklists, Alper placed little to no emphasis on a mentor's potential to provide feedback to students as they complete a project. If anything, the focus of these extended mentor relationships was meant to support a student's ability to manage their time and find resources, all while building trust with an adult who has the potential to provide post-graduate support (Alper, 2017).

Casey (2018) extended the call beyond mentorships to include internships, work-based learning opportunities, and partnering with community assets to develop project-based learning experiences. Similarly, in a recent report published by the Brookings Institute, an organization focused on independent research and policy solutions, a call for re-imagining education advocated the expansion of the teaching ecosystem to include professionals within the school's community (Istance et al., 2019). However, PBLWorks (2019), formerly BIE, failed to mention the use of SMEs in an authentic learning context

as part of its Gold Standard of PBL framework. Similarly, Lombardi (2007) never considered the inclusion of SMEs as part of the ten design elements of authentic learning as a subset of PBL. Furthermore, while Age of Agility recognized the need for employers to participate in the education process through policy making changes and curriculum design, they overlooked the power that connecting SMEs to the classroom can have on preparing our learners for the world beyond that classroom (Gaulden & Gottlieb, 2017).

Through a series of interviews, observations, and survey responses of students enrolled in an integrated STEM program that incorporated English language arts and social studies into the traditional STEM courses, researchers found levels of student engagement and the development of creativity and project management skills improved with secondary students involved in PBL experiences (Hendry et al., 2016). Again, no interaction with SMEs was noted. While engineering skills were also found to improve in this study, the specific engineering proficiency of the teachers who designed the projects compared to engineering SMEs was not reported. In a review of six case studies, through interviews and analyses of documents, Suwaed and Rohouma (2017) reported an increase in student motivation and sense of ownership in the project, leading to improved performance overall. However, in this same study, teachers reported struggling with managing the project environment, which may have been helped with the introduction of SMEs (Suwaed & Rohouma, 2017).

There are several guidebooks designed to help teachers and trainers effectively use SMEs in the classroom. Ludwig and Owen-Boger (2018) admitted that SMEs are often unprepared for working with learners as the duo realized that while SMEs are experts in their designated field, they are not classroom experts and need assistance when

tasked with providing feedback to learners. Here, Alper (2017) provided a straightforward guide on how to connect mentors with classrooms as her "rules of engagement" include how to listen empathetically, create a safe space, and reserve self-judgment (p. 72). It is most important to remember, however, that the "learning conversation" between a student and an SME is "understandable, relevant, and useful" (Ludwig & Owen-Boger, 2018).

Much of the research on PBL, to date, has not included the impact that SMEs have on classroom practice. However, several studies over the last decade and a half exist on the positive effects of PBL in the classroom, but, again, fail to mention the connection to SMEs (Creghan & Adair-Creghan, 2015; Hendry et al., 2016; Lee & Kolodner, 2011; Maxwell et al., 2005). Many PBL research studies focused on student engagement, the promotion of lifelong learning skills, and the increased retention of students in a particular field of study (Almulla, 2020; Boaler, 1998; Goh, 2014; Hall & Miro, 2016; Morales et al., 2013; Ram et al., 2007; Thomas, 2000). Additional research was found related to the impact of building collaborative teacher networks on student achievement, increased student attendance, and increased graduation rates (Creghan & Adair-Creghan, 2015; Moolenaar et al., 2011; Thomas, 2000). Similarly, an examination of a university-level study by Mills and Treagust (2003) found an increase in student motivation and improvement of collaborative skills but did not examine the impact of working with SMEs in a PBL environment potentially has on student outcomes. However, in their review of the PBL literature, Kokotsaki et al. (2016) concluded that no causal link existed between PBL instruction and positive student outcomes. Moreover, except for the aforementioned how-to books for SMEs, more recent books that attempt to explain how

to propel education at least into the current decade, if not for decades to come, mostly fail to mention the asset that SMEs provide as classroom collaborators.

Markham (2016) widely discussed collaboration between teams of students and promoted the use of teachers as mentors to improve student work but never explored the benefit of bringing SMEs into the conversation. Tweed and Seubert (2015) frequently discussed how students presented to authentic, adult audiences. Again, they did not mention how those adults might be integrated for feedback purposes throughout the project process but rather discussed, in detail, the use of teachers as project advisors (Tweed & Seubert, 2015).

Case (2016), a business entrepreneur rather than an educational expert, explored potential education transformation and promoted the need for students to network with one another as they develop partnerships that can grow into learning communities. Although, he failed to explore the power of developing networks peppered with SMEs as part of that growth. Briefly, *Setting the Standard for Project-Based Learning* mentioned the use of SMEs (Larmer et al., 2016). The more recent follow-up to that text, *Project-Based Teaching: How to Create Rigorous and Engaging Learning Experiences*, addressed the seven traits necessary of teachers in a PBL classroom but neglected to provide guidance on the use of SMEs beyond potential collaborators on project development with teachers (Boss & Larmer, 2018).

Ted Dintersmith (2018) described a multitude of school examples with only one small mention of SMEs at Acton Academy in Austin, Texas, where there is no expectation for classroom facilitators to be SMEs. However, Dintersmith's (2018) reference to SMEs called for them to be the experts on how to teach a subject within the

classroom walls, much as we expect traditional teachers to be defined. Additionally, Dintersmith (2018), while not requesting SMEs provide feedback to students specifically, briefly described the need for adults in the community to connect to schools to provide internships and become mentors.

Even though Lombardi's (2007) review of authentic learning mentioned a great deal of community collaboration, she limited her discussion to collaboration with other students. There was no specific inclusion of SMEs that made it into Lombardi's authentic learning review. *The STEM Shift: A Guide for School Leaders* (Myers & Berkowicz, 2015), a book one might expect, by its sheer title, to call for the interaction of SMEs as project partners, simply referred to self and peer assessments and reflections as modes for feedback on one's work.

What also lacks in the literature to date is how our experts can learn from our students through SME to student interaction. As discussed in a collaborative effort between the Institute for the Future and Lumina Foundation (2018), "learning to learn," which includes active listening and the ability to regulate one's attention, is one of the most critical skills for workers in the future (p. 13). Briefly, in a report of innovative schools worldwide, The World Economic Forum (2020) described Finland's top-performing high school, South Tapiola, and their partnership with companies to provide feedback on how to improve their products. However, in the first review of literature, this example was the only result related to students giving feedback in the real world.

SME Feedback

Few educational books have delved into the possibilities of how SMEs can provide value-added feedback to improve student work. Thomas and Brown (2012) spoke

in general terms to advocate for the creation of learning collectives rather than learning communities in which we can learn *with* one another rather than *from* one another as we tap into a "nearly infinite set of resources" (p. 59). Lave (1991) discussed the need for "legitimate peripheral participation" through "communities of practitioners" in which "newcomers" interact with "old-timers" through apprenticeships but never specified the need for SMEs to provide feedback on the authentic work that students complete (p.29). Laur and Ackers (2017) discussed how to utilize SMEs as more than guest speakers and their potential to help teachers and students co-create authentic project learning experiences. Dobbertin (2010) extensively explored how feedback from experts allows students to improve their work. Dobbertin (2010) also noted feedback from a teacher does not have the same exciting or relevant impact as the feedback from a subject matter expert as revealed to her in an interview with Ron Berger, Chief Program Officer for EL Learning. Again, Alper (2017) provided the most recent exploration of how SMEs provide support and feedback to students as they work through challenges, as she offered guidance on how to function as a teacher, student, and mentor in a project-based setting. However, Alper (2017) promoted this SME support in a hypothetical situation solved in the real world rather than an actual authentic challenge connected to the real world.

Research related to feedback for students on authentic tasks is limited. Little to no research exists solely around the use of SMEs in the classroom as feedback providers to improve student work. Much of the focus on the classroom use of SMEs has been in their capacity to offer low-level Bloom's information about job-related tasks, skills, and requirements (Alper, 2017; Fisher & Fisher, 2018).

The majority of existing research studies have tapped into peer collaboration as a benefit for student work but failed to recognize the potential for SME connections with students. Lee and Kolodner (2011) conducted a descriptive study that explored a comparison between a U.S. classroom and a Malaysian classroom that implemented a PBL experience related to stormwater management and flash flooding. The study's outcome indicated this approach improved critical thinking skills to help students learn to be creative, but it relied on peer feedback for improvement to proposed solutions rather than connect students to SMEs for a higher level of feedback (Lee & Kolodner, 2011). While not explicitly related to authentic PBL, a look into how virtual reality classroom connections promote student engagement found a positive association between peer support and final student products (Morales, Bang, & Andre, 2013). Additionally, Harrington and Oliver (2000), in an "observer as a participant" study, found student acquisition of higher-order Bloom's information occurred, and the need for predetermined feedback was eliminated when using situated learning frameworks in authentic contexts.

Recently, attention to the development of networks for students to increase their capacity to build impactful relationships shows support for their social and economic mobility once they leave school. Historically, schools have ignored their role in this process (Fisher & Fisher, 2018). Fisher and Fisher (2018) offered examples of schools, such as the Big Picture network, which seeks to develop internships as a part of their curriculum to increase the size of the impact of student networks. Reviews of tech tools, such as iMentor, detail the benefits of how the connection between a mentor and a student serves as an avenue to provide college advice and help in studying for the SAT

(Fisher & Fisher, 2018). However, the reviews offer little attention on how to pull these mentors into a relationship that provides feedback on student work within the classroom, nor do the reviews offer advice on how to support teachers in their capacity to develop authentic project learning experiences that are a reflection of the work that the SMEs do in the real world. If anything, Fisher and Fisher (2018) argued why education systems must shift their attention to how to begin to disrupt education. While the authors regarded their provided examples as "innovations," it does little to give truly disruptive examples (Fisher & Fisher, 2018, p. 120). Conversely, calls for radical changes within the system have begun from advocates such as Zhao & Watterston (2021) who have argued COVID-19 creates an environment ripe for radically changing educational systems and functions.

As students increase in age and experience, there is a better chance they make connections to the world of work in a broader context through the educational experience. Post-secondary polytechnics are a mainstay in Singaporean education where students receive specific opportunities to connect to "emerging industries" to support growing demand by the country's economy (Goh, 2014, p. 159). Specifically, Republic Polytechnic has adopted a "one-day, one-problem" approach to learning that challenges student teams to solve a problem directly related to an industry with an assigned facilitator who has passed a certification process established by the school (Goh, 2014, p.161). Moreover, the school has brought in these facilitators after having evidence of successful careers in an industry outside of education, such as applied science or engineering, with no formal university training in education (Goh, 2014). However, this three-step process to the "one-day, one-problem" approach only includes problem analysis, self-directed learning supported by teacher facilitators, and the reporting phase;

it does not include any connections with SMEs to improve the solution to the problem, nor does it require the solution to be implemented outside of a classroom presentation to peers (O'Grady et al., 2012).

Over the last few years, the establishment of several organizations that attempt to facilitate connecting classrooms to SMEs has become more prevalent on a small scale. A variety of these organizations merely work to make these connections on a local level and are based on word of mouth, such as the futurePREP'd referenced previously. Other programs, such as Community Share of Tucson, AZ, have tapped into the power of online connections but remain mainly a local connection network. (Community Share, n.d.). Community Share (n.d.) connects regional local community partners that have skills and experiences to enhance classroom and informal learning environments. However, while these connections might facilitate the development of authentic project learning experiences, the organization also revealed these matches may simply be used to create mentorships, host field trip experiences, or judge academic competitions such as science fairs (Community Share, n.d.).

While more widespread than Community Share, LRNG maintains fourteen network connections with cities, such as Washington D.C. and Detroit, or specific community partnerships, such as Point Defiance Zoo (LRNG, n.d.). These network connections provide inner-city youth with the ability to follow a thematic "playlist" set of resources and learning experiences (tool, game, or online content) that lead students to potentially earn a badge, which in turn qualifies them for an internship or possible job (LRNG, n.d.). While this opportunity ultimately may lead to real-world experiences and a

connection with a mentor, there is no inherent connection to an SME for feedback on student work within the classroom experience.

A few groups, namely Nepris, have focused their efforts on building a more extensive virtual network that has the potential to create national and international systems of SMEs, but primarily only connects these SMEs with classrooms in the role of a talking head designed to impart information about their current occupation (Fisher & Fisher, 2018). Nepris has also joined forces with Real World Scholars (RWS) to connect students to their broader communities as they showcase their learning on an authentic stage (M. Crawford, personal communication, October 1, 2018). This desire to create a connection marks an understanding that not all students have the local option to be connected due to location, demographics, and geographic constraints (M. Crawford, personal communication, October 1, 2018). Thus, the EdCorps platform was born to develop an e-commerce website to ensure students have the market space for their products and support for their business (Real World Scholars, n.d.). However, RWS has noted that while they pay for a service (Nepris) that provides SMEs for classroom connections, not every EdCorps classroom takes advantage of this offering (M. Crawford, personal communication, October 1, 2018). As more of these organizations come to fruition, one thing remains constant: the separation between education and the business world will continue to decrease (Blivin & Mayo, 2018).

The World Economic Forum (2020) reviewed multiple school systems worldwide for examples of successful programs in their quest to redefine educational spaces into ones that develop students who are ready for an innovation-driven economy. Several educational institutions included connections to SMEs. The Accelerated Work

Achievement and Readiness for Employment in Indonesia, which partners with companies such as BMW and LG Electronics, reported that 57% of their program participants improved their employability (World Economic Forum, 2020). Additionally, as previously mentioned, Finland's South Tapiola schools partner with companies such as Hewlett Packard to provide feedback on how to improve their products (World Economic Forum, 2020).

How one gives feedback can impact how well it is received and its effects (Blunden et al., 2019). In their recent Harvard study, researchers found that feedback often has no (or negative impact) on one's performance due to how the feedback is presented (Blunden et al., 2019). The researchers' collaborative team conducted four experiments in which they asked SMEs to provide either advice or feedback to their subjects (Blunden et al., 2019). The findings from the four experiments split the groups into those who asked for advice versus those who asked for feedback (Blunden et al., 2019). The researchers determined those who asked for advice received applicable information that was more effective than the feedback groups (Blunden et al., 2019). Moreover, the researchers concluded that feedback was seen as evaluative and was often vague and generally praised, while the advice was considered more critical and actionable for future changes (Blunden et al., 2019). This most thorough study on feedback to date noted, however, that novices of a topic might prefer feedback instead of advice due to the less intimidating nature of the comments (Blunden et al., 2019).

Often, feedback is the focus of workplace environments rather than educational contexts. Researchers with Gallup have provided the need for coaching conversations as ongoing dialogue for improvement rather than infrequent instances of one-way feedback

that tend to focus on mistakes that cannot be changed as only 26% of workers surveyed strongly agreed that the feedback they received, helped them to improve as workers (Wigert & Dvorak, 2019). The merging of teachers and SMEs as collaborators in the design of authentic project learning experiences coupled with providing feedback to learners is an untapped resource for exploration.

While not related to students working directly with companies for product design and feedback, Alper (2017) explored the benefit of corporations giving back to the community through mentorship in the discussion of several case studies, but she did not engage in the potential for students to enrich the lives of the mentors with whom they work. Furthermore, she did not consider the value-add of students who can solve these corporations' challenges as they bring an entirely new perspective on the problem. Meanwhile, Ludwig and Owen-Boger (2018) recognized the importance of conversations between SMEs and learners as the relationship contains a duality of purpose for both parties. Thus, the potential for SMEs to learn alongside the school students with whom they partner is an added benefit that deserves exploration.

Networked Connections

Students have very little, if any, personal say in where they grow up and what school they attend. Economic circumstances are frequently the predictor of student connections, while the rest is left up to chance (Fisher & Fisher, 2018). Fisher and Fisher (2018) discussed the "relationship gaps" due to an increase in neighborhood segregation, the unequal amount of time that college-educated parents spend with their children in relation to those who are less-educated parents, and the fewer instances of enrichment activities provided to lower-income children than their more economically advantaged

peers (p. 20). In turn, less diverse communities and wealthier neighborhoods typically have the most access to out-of-school networks. An impact on the upward mobility trend of students results. Therefore, working with community partners brings students into contact with future employers (Lombardi, 2007).

Creghan and Adair-Creghan (2015) explored the positive impact that economically disadvantaged high school students experienced when exposed to a PBL classroom setting. In their comparative study, Creghan and Adair-Creghan (2015) found that students in the PBL school attended school more frequently than their peers in the traditional school setting. However, researchers did not look at the potential for a positive impact that these economically disadvantaged students could experience when connected to an SME to build the necessary network of support noted by Fisher and Fisher (2018). The importance of this type of networked connection in economically disadvantaged schools is highlighted by Aaron Smith's (2015) Pew survey, which indicated more than half of all respondents relied on network connections, either through friendships or professional networks, to find potential employment. Thus, contacts and networking building are essential beyond the school years. These relationships and connections made during one's years in schools have the potential to pay off in the future.

Internships shape the majority of the student-to-mentor connections that happen. Many of these internships resemble a job-shadow day or are equivalent to extended time on the job with the mentor to observe the career's tasks. Eventually, these interns take on roles that require them to complete projects for the internship site. Fundamentally, feedback is a part of this process, as is networking. However, outside of the internship model, few schools have currently bought into a systemic connection between student

work and input provided by SMEs to build lasting networks. In one such example, however, ACE Leadership High School in Albuquerque brings both worlds together as mentors help develop the projects from a client and user-needs perspective and also provide feedback on student work used in the real-world (Vander Ark, 2018).

Interviewed SMEs, in an ethnographic study conducted at King Middle School in Portland, Maine, revealed a value in working with students to pass on their professional interests to the next generation of potential workers in their field, as well as to make an impact on students' lives in general (Rheingold & Seaman, 2017). Similarly, in a case study in a college technical writing course, through a series of interviews and follow-up email correspondence, Liu (2015) discovered students who participated in authentic project learning experiences connected directly to their community stayed involved in the community effort directed toward actionable change after the course concluded. Furthermore, Fisher and Fisher (2018) developed the concept that student networks are what promotes an entrepreneurial spirit linked closely to the position mentioned above of Zhao.

Standards Alignment

The research on authentic PBL and SMEs is limited; although, a closer look at specific standards from various organizations aligns with the mission of creating authentic PBL in educational settings. Much effort has gone into redeveloping international standards to ensure a deeper connection to higher levels of thinking and learning, both from a student and teacher perspective. However, these standards have largely ignored the role that SMEs can play in increasing student understanding, achievement, and excitement about learning. While not specific to a particular

pedagogical approach, a review of the International Society for Technology Education (ISTE) (2017) Standards for Students reveals a shift in teacher expectations of how students learn in the classroom. Specifically, the call for students to become global collaborators, empowered learners, creative communicators, knowledge constructors, and innovative designers, among others, is prevalent throughout the standards' wording (ISTE, 2017). Within these standards, there is no mention made of the use of SMEs to support the implementation and achievement of these standards.

Moreover, the ISTE (2017) Standards for Educators call teachers to action in the space of collaboration that is specific to designing learning experiences and solving problems with both colleagues and students. The omission of a list that includes SMEs as potential collaborators comes into question and perhaps leaves room for inclusion in a future release of the standards. Furthermore, in this same vein, the standards ask educators to become learners as they develop "professional learning networks" with like-minded colleagues to start conversations around improving classroom practices (ISTE, 2017). Yet, there is no mention of the benefits of the use of SMEs in any of the standards as it relates to classroom implementation or expectation.

In recent years, a shift in how students use technology in the classroom is apparent even if the classroom-to-SME connection is not. ISTE's Standards for Students reflect this shift from a focus on productivity purposes in the late nineties to the use of technology for assistance in developing higher-order thinking skills and collaboration in the mid-2000s (Snelling, 2016). The most recent refinement of the standards in 2016 saw an almost complete departure from learning with technology to a goal that seeks to transform teaching and learning linked easily to any given content standards from a state,

district, or individual course (Snelling, 2016). While not explicitly mentioned by name, within the seven revised ISTE Standards for Students, several specific indicators can be linked directly to the use of SMEs in the classroom. ISTE (2017) student indicator 1b, under the umbrella standard of Empowered Learner, cited the need for students to "build networks," and student indicator 1c noted the "use of technology to seek feedback that informs and improves their practice" (p.4). Specifically, under the umbrella standard of Knowledge Constructor, while no mention is made directly connected to SMEs, the call for learners to tackle authentic challenges is signaled for in indicator 3d (ISTE, 2017). Likewise, indicators 4a and 4c, under the standard Innovative Designer, combined the need for solving authentic challenges with the knowledge that prototypes may not work the first time (ISTE, 2017). This standard provides the perfect opportunity for feedback from SMEs. *ISTE* (2017) standard 7, Global Collaborator, is the most direct connection to SMEs. Indicator 7b of the Global Collaborator standard draws on the need for learners to connect with "peers, experts, or community members" to use technology to work toward a solution to a challenge by considering "multiple viewpoints" (ISTE, 2017, p.5).

An examination of the College, Career, and Civic Life (C3) Framework, developed by the National Council for the Social Studies (2013), revealed the critical need for students to develop the ability to identify problems within society and derive solution-oriented ideas from their investigations into these problems that have the potential for implementation. A careful review of the C3 Framework does not require the use of SMEs as support for learners as they develop solutions to given challenges. The Next Generation Science Standards (2013), designed by a coalition of representatives from the 50 States, are intended to promote science and engineering practices but do not

expressly advocate for the use of science, math, and engineering experts to ensure students see the real-world value in the standards. Similarly, but for math and English language arts, the Common Core State Standards (CCSS) (2011) were developed by representatives from 48 States to ensure students were ready for college or a career once leaving K-12 education. While presentations of findings are important throughout the ELA strand of standards, the CCSS makes no specific mention of the utilization of SMEs within these standards, and one might infer the teacher as a suitable adult for providing the required audience. Furthermore, there is no specific mention of using SMEs for feedback in the preparation of these presentations.

Theoretical Underpinnings

Constructivism: Dewey, Bruner, Piaget, and Vygotsky

The twentieth century saw the rise in active, constructivist learning that denounced the passive memorization of facts (Adams, 2006). Constructivism draws on the works of multiple educational institutional figures that include Dewey, Bruner, Piaget, and Vygotsky (Adams, 2006). As early as the start of the Second Industrial Revolution, Dewey advocated for a change in education to reflect the change in society as he called for what is now the oft-quoted phrase, “learning by doing,” rather than engaging in learning as a passive activity (Duffy & Cunningham, 1996, p. 4). Today, as we embark on what Schwab (2016) calls the Fourth Industrial Revolution, technological advancements such as artificial intelligence and quantum computing will come to fruition. It is now time for education to reflect the changes in society once again as we make a shift toward what Fisher and Fisher (2018) described as “a merge [of] academic,

social, and community factors into a coherent institution that does pave the way to opportunity" (p.156). Here, educational systems are ripe for constructivist learning.

Some consider constructivism as a theory of knowledge or learning; others focus on it as a teaching pedagogy (Amineh & Asl, 2015). Pedagogically, constructivism links to the active learning required in PBL's inquiry-based, problem-solving approach. Although, no matter one's level of education or how formal education occurs, constructivism happens as everyone constructs meaning out of events that occur (Newmann et al., 1996). Thus, constructivism, as a "metaphor for learning," has both strengths and weaknesses (Fox, 2001, p. 24).

If constructivism applies to all teaching approaches, one might argue that no specific pedagogy is considered best practice. Fox (2001) even noted that a more passive learning approach is necessary when creating new constructs. Although, Lebow (1993) asserted active constructivism helps learners experience fewer "potentially damaging effects of instructional practice" that are more traditional, including "delayed independent thinking" (p. 5). Similarly, Ausubel, who was widely influenced by Piaget, noted students make sense of new knowledge by determining how that knowledge is used in daily life (Agra, et al., 2019). Ausubel, Novak, & Hanesian (1978) claimed what the student knows before a learning experience happens is the most important factor in determining how to teach that student. Ausubel (2000) further explained this phenomenon as anchoring ideas that allowed a learner to make sense of relevant ideas. Moreover, the psychologist noted pedagogical approaches that are meaningful will develop learners who do more than memorize information that is quickly forgotten, and instead promote long-lasting knowledge (Ausubel, 2000).

With its wide acceptance in modern education, nearly every non-lecture pedagogical approach receives the label of constructivism (Duffy & Cunningham, 1996). This label leads to some concerns. The inability to define the level of what one learns based on an individual construction of that knowledge and a lack of shared meaning of what individuals construct can be troubling to some (Duffy & Cunningham, 1996). Counter to this, Duffy and Cunningham (1996) also reviewed the ability to share meaning by seeking to understand different perspectives. More importantly, the pair noted a shared meaning does not require one to accept the expert's understanding from whom the meaning is shared, but rather the requirement to "seek to understand and challenge the learner's thinking" (Duffy & Cunningham, 1996, p. 2). Duffy, this time in conjunction with Savery (1996), noted shared meaning comes through collaborative grouping. Here, individuals can test their understanding of concepts and explore the understanding of others to enrich the collective understanding that results (Duffy & Savery, 1996).

Teachers are often concerned about the possible hands-off teaching approach that translates into hands-on learning associated with constructivism. In fact, Fox (2001) asserted that as an active approach to learning, constructivism lacks the qualities of reactive learning. However, Amineh and Asl (2015) charged teachers with developing classroom environments that "challenge the assumptions of traditional teaching and learning" (p. 12).

A review of the literature revealed studies that found constructivist learning favorable to traditional teaching methods. In Kim's (2005) pre-test/post-test experimental design study of 76 sixth graders, findings revealed higher academic achievement in the constructivist group of students who also preferred the method to traditional teaching. At

the post-secondary level, the results are similar. In an experimental study of 60 preservice math teachers, Narli (2011) found that the students in the constructivist learning group retained academic content better than those in the traditional teaching group. A 2015 meta-analysis found that 50 of 53 studies found that the effects of constructivism on teaching environments showed positive academic achievement results compared to traditional teaching methods (Ayaz and Sekerci, 2015).

Those that criticize constructivism as a pedagogical approach point to neuroscience as an indicator of why educators should be cautious in their sweeping applications that may allow students to learn without the support of the teacher (Arsalidou & Pascual-Leone, 2016; Hobbias, 2018; Rothbart, & Posner, 2015). Hobbias, (2018) noted constructivism as a learning theory rather than pedagogy reminds teachers that scaffolds must be facilitated to support learners as they construct meaning through a hands-on learning approach. In fact, counterintuitive to the PBL approach, Hobbias (2018), argued schemas must first be developed in order to have a successful constructivist classroom. Likewise, Arsalidou and Pascual-Leone (2016) concluded building schemas lead to later learnings which can be constructed from those schemas. Thus, it is important to ensure teachers tap into existing schemas through supported lessons.

Importantly, Chrenka (2001) noted that constructivist teachers do not fade into the background and leave their students to work in seclusion from their instructor, but rather teachers support their students with their expert knowledge in their content area certification. As such, Chrenka (2001) identified the need for teachers to be experts in their field to be able to “develop the scaffolding strategies necessary for learners to

construct their own meaning" (p. 694). In doing so, Chrenka (2001) failed to recognize that this expert knowledge often is limited to a degree without any real field experience in the content area.

Fosnot (1989) defined four principles of constructivist learning: (1) the rate of learning is affected by what students already know prior to the learning experience (2) old ideas are influenced and adapted based on the learning experience (3) learning is not mere memorization but requires the invention of new ideas (4) learning happens when old ideas are transformed into new ones. Learning occurs when "the learners build an internal illustration of knowledge… [as a] personal interpretation of the experience (Amineh & Asl, 2015, p. 11). Furthermore, Fox (2001) contended that knowledge construction is both an individual and social experiment based on the changing culture of one's environment. However, it is essential to note that constructivist teaching approaches are often mislabeled to include any active teaching strategies (Shah, 2019). Instead, constructivist approaches should be linked directly to teacher-facilitated classrooms that balance student-directed learning with teacher support (Shah, 2019).

While advocates for constructivist learning tout the development of open-ended challenges instead of rote memorization, we must consider the downfalls of this pedagogical approach to learning. Not every learner is engaged in an active, constructivist view of learning. Rather, Fox (2001) noted the importance of ensuring a student finds the challenge "interesting and satisfying" (p. 33). Moreover, Fox (2001) concluded that the constructivist learning process must include teacher facilitation of shared knowledge through instruction that leads to the completion of open-ended challenges; however, he did not address the need to have SMEs as part of this process.

Parallel to this view, Packer and Goicoechea (2000) posited the importance of learners' members of a community that includes the need for expertise on various levels to enhance students' understanding.

Zone of Proximal Development: Vygotsky

The zone of proximal development (ZPD) pushes the boundaries of constructivism. As interpreted by Vygotsky in the early twentieth century, social constructivism was developed as an application to the psychological development of children but was never linked by him to a specific pedagogical practice (Fani & Ghaemi, 2011). However, in a targeted criticism about classroom practices, Vygotsky (1962) noted, "direct teaching of concepts is impossible and fruitless" (p.150). Without a direct link from Vygotsky to a pedagogical practice, the theory's underlying premise is reviewed here in the context of its application in authentic project-based learning environments.

ZPD was developed as a result of Vygotsky's cultural impacts while living during the Russian Revolution, and as a result, ZPD requires social interaction to develop skills (Fani & Ghaemi, 2011). Specifically, the ZPD is complemented by collaboration with others to build on a student's existing abilities (Cole & Cole, 2001). Vygotsky (1978) believed that learning occurred within oneself only after it transpired on a social level. Thus, the imitation of others discussed by Vygotsky (1987) is meant to go beyond the mere copying of actions and into the realm of understanding structural similarities within a given problem to solve a new or similar challenge. From this, we can derive theoretical underpinnings of the importance of ZPD in connection to authentic PBL that utilizes SMEs. Furthermore, the ZPD is not a fixed asset for a learner but one that continues to

grow based on the number of interactions one has with adult guidance or a capable peer (Shabani et al., 2010).

Vygotsky's ZPD theory can be considered the basis for the need for scaffolding of content (Shabani et al., 2010). Since most educators do not have a working background outside of education, unlike SMEs, it can be inferred that SMEs can scaffold content for learners through the feedback process as they question students about their actions and the consequences of those actions. As the ZPD is the gap between which a learner can accomplish a task on his or her own and where the learner needs assistance from another who is an expert, the likelihood that a learner will shrink the gap between the two points after each subsequent learning experience increases (Shabani et al., 2010). Thus, feedback from an SME has the potential to shrink the ZPD gap.

The Project Method: Kilpatrick

Kilpatrick was partially influenced by constructivism through coursework he took from Dewey and Cornell University's Charles DeGarmo, who advocated focusing on student-led interest to guide learning; these influences led Kilpatrick to adopt what is now referred to as the Project Method (Pecore, 2015). The Project Method is defined as "a sub-form of action-centered and student-directed learning… in which [learners] engage in practical problem solving" (Knoll, 2014, p. 665). Moreover, Kilpatrick noted community connections to classroom content created a student who became a contributing member of society (Pecore, 2015).

In his Project Method, Kilpatrick noted four approaches to developing projects: external plan creation, esthetic experience creation, problem-solving, or skill acquisition, with the latter carrying a caveat to ensure it did not merely become a low-level learning

experience (Pecore, 2015). In all four approaches to project implementation, Kilpatrick (1918) noted the requirement that projects have a purpose for the learner. In its purest form, the Project Method and Kilpatrick advocated for learner-chosen projects to meet the purpose requirement (Wolk, 1994). Notably, Kilpatrick (1918) wrote in his famed essay explaining the Project Method, "as the purposeful act is thus the typical unit of the worthy life in a democratic society, so also should it be made the typical unit of school procedure" (p. 323). However, in the early twentieth century, Kilpatrick made scant mention of the need for SMEs within the classroom. Instead, he advocated for the gradual removal of a skilled teacher to allow for individual student growth as a learner (Pecore, 2015). In fact, in its ideal form, Kilpatrick believed students engaged in a project without any help from the teacher from the project's conception through its conclusion (Knoll, 2014).

Kilpatrick's peers of the time criticized the complete removal of the teacher and the assumption that children's interests were the only ones from which they could learn (Knoll, 2014). Today, it is almost impossible to find the complete removal of the teacher. Instead, learner choice often comes in the form of a project proposal, list of possible resources, how the student plans to share what they've learned, and a final reflection after a class presentation (Wolk, 1994). Thus, we do not see the inclusion of the SME connection to learning through the original Project Method. Moreover, today's learner choice, in its more frequent sense, can miss some of the key elements of PBL aligned to higher levels of Bloom's thinking. However, it must be noted that at the turn of the twentieth century, education could not connect to SMEs as it does today. With the rise of the Second Industrial Revolution, skilled jobs were mostly considered trades, and the

majority of employees did not have the time during the workday to connect to students. The eventual onslaught of the Progressive Era would see an increase in the number of real-world challenges society faced. However, the use of Kilpatrick's Project Method was limited, and students of this era were unlikely to come into contact with it. In fact, Dewey also criticized the method as being too free in its allowance for learners to select their projects to pursue (Knoll, 2014).

Since its inception in 1918, the Project Method has served as a basis for the growth of other pedagogical approaches such as PBL. Most notably, Chard (2011) referred to the project approach as a "set of teaching strategies… that guide students through in-depth studies of real-world topics" (para.1). Furthermore, Chard (2011) indicated in phase two of the Project Method's planning process that students conduct fieldwork and interact with experts. From this, the inference that the introduction of an SME would allow for even more learner growth is present, as it includes an adult who can provide feedback on real-world challenges without removing the teacher.

Since the days of Kilpatrick, the Project Method has been re-envisioned for modern-day pedagogical applications. The method has been further refined and developed over the last century into a variety of pedagogical approaches. While there are slight variations in the practice, such as problem-based, challenge-based, and inquiry-based learning, the most frequently referenced is project-based learning (PBL). PBL has gained the most traction in the last two decades (Education Reimagined, 2015). Specifically, PBL does not include any "predetermined outcomes" led by a teacher (Thomas, 2000, p. 4). Instead, PBL units require learners to solve authentic challenges with student-driven solutions with the possibility of implementation (Thomas,

2000). This definition of PBL aligns with Kilpatrick's Project Method of over one hundred years ago.

While no one agreed-upon definition exists for project-based learning, the newly designated High-Quality PBL lists six elements as necessary proof that the criterion for the distinction: intellectual challenge and accomplishment, authenticity, public product, collaboration, project management, and reflection (Mergendoller, 2018). This pedagogy is reflective of the constructivist approach to learning by which the actual construction of one's knowledge individually develops as the learner interacts within their environment (Crotty, 1998; Duffy & Cunningham, 1996). While no specific reference to SMEs occurs within the framework of High-Quality PBL, there are plenty of opportunities to extend several of the criteria into alignment with these six referenced elements.

Beineke (1998) noted Kilpatrick's optimism that the Project Method would evolve into a modern-day pedagogical practice that would lead to learner advancements in critical thinking to adapt to new social conditions. Reflectively, this is also in alignment with the use of SMEs as classroom partners, as the extension outside of the classroom walls breaks the barrier between school and society as separate entities. However, it cannot be ignored that one of the struggles indicated by teachers who implement PBL is the need to remain in control of when and how expert knowledge is disseminated (Ladewski et al., 1994). This struggle is counterintuitive to the connection between classrooms and SMEs. Many teachers consider themselves to be content experts as well as the trained education expert. However, unless the teacher came to education from another field, they have never professionally put that content into practice in the world outside the classroom.

Disruptive Innovation Theory: Christensen

Initially, disruptive innovation theory focused only on technology and was later, after a series of criticisms related to the theory, expanded to include other innovative areas (Kumaraswamy et al., 2018). While disruptive innovation theory maintains initial developments are considered inferior to their predecessors (sustaining innovations), these disruptions eventually meet mainstream markets' needs (Yu & Hang, 2010). Now, more than two decades after the theory's first proposal, we can see how the world of education must prepare for disruptive innovation.

As education at all levels has mostly remained unchanged in the last 150 years, the entire system is ripe for disruptive innovation. The application of disruptive innovation often belongs to any broad and loosely defined areas that attempt to shift from the norm (Christensen et al., 2015). However, as the founding theorist behind disruptive innovation and his colleagues noted, "disruption begin[s] by successfully targeting … overlooked segments, gaining a foothold by delivering more-suitable functionality" (Christensen et al., 2015, p. 4). This foothold has potential in many different environments within education. Hence, it is unlikely that the most affluent, test-successful populations across the nation look to be disruptive. These affluent schools are more apt to continue with the accepted frameworks that are difficult to ignore, as their culture and environment may not accept the change (Yu & Hang, 2010). Conversely, teachers who are "renegades who thrive and change and take risks" are ready to move into the authentic learning approach described by Gordan (1998) as real-life problems (para. 6).

"A disruptive innovation is not a breakthrough improvement" (Christensen et al., 2017, p. 47). No part of the theory claims that disruptive innovation will replace the sustaining innovation (Yu & Hang, 2010). As it stands, the school system's current structure has attempted to retrofit new technologies into the developed ecosystem that has been around for decades (Christensen et al., 2017). This sustaining innovation model has done little to improve the quality of education. To shift from sustaining to disrupting, Christensen et al. (2017) recognized that the disruption must first occur outside of schools before it can happen within schools.

The segments of schools that typically find it challenging to make the grade are ready for a disruptive education approach. More specifically, they are prepared for disruptive technology. A disruptive technology is defined as "the processes by which an organization transforms inputs of labor, capital, materials, and information into products and services of greater value" (Christensen et al., 2017, p.11). However, disruptive innovations are not likely to catch on with the mainstream population until the standards prove that the product's quality exists (Christensen et al., 2015). Appropriately so, disruptive innovations are considered to be a process rather than an end product due to the amount of time it takes for the innovation to be accepted (Christensen et al., 2015). Moreover, Lee & Kolodner (2011) defined creativity as the ability to solve challenging problems when confronted with limits, as they apply their understanding to a new situation. This definition is in line with disruptive innovation theory, as creativity requires one to innovate.

Parallel to Lee and Koldodner's (2011) description, the Organization for Economic Cooperation (OEC) (2021) defined creative thinking in their third draft of the

Framework for the Assessment in Creative Thinking. OEC's Programme for International Student Assessment (PISA), which is designed to measure math, science, and reading outcomes for 15-year-old students around the world, will use the following definition for their 2022 test: "The competence to engage productively in the generation, evaluation, and improvement of ideas that can result in original and effective solutions [as it] advances in knowledge and impactful expressions of imagination" (p.8). This definition aligns with the project-based learning definition of Markham et al. (2003) and the definition of authentic learning by Newmann et al. (1996).

The early changes toward a more constructivist way of learning in the late nineties align with what Christensen calls a sustaining innovation or a new product that enters the market in a small way and begins to diffuse upward (Schmidt & Druehl, 2008). This sustaining innovation is Zhao's more academic approach to project-based learning aligned with Kilpatrick's Project Method and Dewey, Bruner, Piaget, and Vygotsky's approach to constructivism. PBL has become a pedagogical choice for schools looking to move into the 21st century of education. PBL as a sustaining innovation is in contrast to the disruptive innovation of authentic learning or Zhao's entrepreneurial PBL that involves the use of SMEs to support, challenge, and empower learners.

A disruptive innovation doesn't necessarily replace the entire market (Schmidt & Druehl, 2008). Moreover, innovative and early adopter teachers first realize the disruptive innovation slowly (Yu & Hang, 2010). These innovative and early adopter groups of teachers typically represent approximately 16% of the population according to the Law of Diffusion of Innovation as the idea starts to take hold and before spreading to the early majority, late majority, and those who are considered laggards (Sinek, 2009). Therefore,

we can expect to see authentic and entrepreneurial PBL connected to disruptive innovation theory take root in this small group before taking hold in mainstream educational systems. However, this century is also referenced as a time for continual disruptions that affect ecosystems beyond simple business models (Kumaraswamy et al., 2018). This readiness very well may lead us into the third decade of the 21st century, prepared for the disruptive innovation of building SME relationships in education.

Disruptive innovations affect relationships between the players within a given stakeholder system (Kumaraswamy et al., 2018). Therefore, stakeholders within education must expand beyond teachers, students, parents, and administrators. The inclusion of SMEs within the educational ecosystem provides a deeper relationship between the community and schools. However, based on the disruptive innovation theory, the disruption's wide adoption does not initially occur (Kumaraswamy et al., 2018). The expectation is that only niche markets will undertake the disruption (Christensen et al., 2015). Therefore, the innovation's presentation affects its ability to successfully enter the mainstream market (Kumaraswamy et al., 2018).

Furthermore, accessibility and affordability, through technology, have provided an ecosystem within education that no longer must rely on space and place to connect only those students fortunate enough to already have a built-in network of support (Fisher & Fisher, 2018). As evidenced by the shift to remote learning during the COVID-19 shutdown of schools, the use of video chats, social networking sites, and learning management systems can serve to transform interactions within and across classroom systems. However, we must also remember that face-to-face connections will remain important. Early results from the remote learning experiment noted half as many hours

spent a day learning, with only 37% of teachers reporting they interacted with their students daily (Education Week, 2020). Instead of focusing on improving what has always worked in our schools, it is time we disrupt education, as we know it, to reimagine learner connections to include SMEs (Fisher & Fisher, 2018). The potential to capitalize on the building of SME connections within an authentic project context exists. Moreover, as a changing landscape of occupations appears over the next five to ten years, so too will there be a shift in the skills required to conduct these jobs successfully.

As recently released by the World Economic Forum (2018), the disruption currently occurring in the labor market needs a new set of skills to successfully meet the changing division of labor between workers and the technology being developed to overtake the jobs humans once had. Thus, tapping into the existing knowledge base of SMEs can better prepare our learners to transform the workplace. This link to SMEs is essential because educators generally do not have workplace knowledge outside of the classroom environment.

Garcia and Weiss (2020) reported the fallout from the educational shutdown during COVID-19 may pave the way for increased technological revolutions in education. However, it must be noted that Zhao and Watterson (2021) criticized the educational shifts during the COVID-19 crisis as ones limited to focusing on how to reach students in an online format rather than using the opportunity to "rethink education" (p. 4). Complicating matters, historically, disruptive innovation through technology in education has been limited. Young and Schachter (2019) pointed out that few incentives existed to create a new market in technology. "In many cases, companies do not want to disrupt an existing market, especially if doing so will compromise their

own market share and viability" (Young & Schachter, 2019, para 3). As such, Adams-Becker et al. (2018) recognized that even though collaborations between education systems and industry are more prevalent today, "more-explicit frameworks and guidelines are needed to define how those partnerships should proceed to have the greatest impact" (p.12). Moreover, those entities claiming to "disrupt" the face of education have misused the term, perhaps. "Many … use 'disruptive innovation' to describe any situation in which an industry is shaken up, and previously successful incumbents stumble" (Christensen, Raynor, & McDonald, 2015, para. 3).

Thus, the utilization of SMEs in the role of guest speakers is not disruptive. Instead, SMEs have the potential to fill the space to provide feedback from the perspective of one who has been in the field and experienced the real-world component of the standards rather than simply share a textbook point of view (Laur & Ackers, 2017). Moreover, while mentors can look over resumes, suggest internships, and provide networking advice, this, too, is not fully effective in the disruption.

Creative Destruction Theory: Schumpeter

While initially developed as an economic application, creative destruction theory applies to many different disciplines, most notably technology, and advocates for the entrepreneur as vital to capitalism (Reier, 2000). Often, the work in Silicon Valley is seen as creative destruction as entrepreneurs, innovators, venture capitalists, SMEs, and others build a complex relationship that is dependent on one another to destroy old systems and create new ones at an unfathomable pace (Henton & Held, 2013).

Technology "innovations" have primarily focused on allowing learners to work at their own pace and, in doing so, are "designed to make the current educational system

more efficient" (Young & Schachter, 2019, para.3) Thus, according to Young and Schachter (2019), inquiry-based educational opportunities abound if true technology innovations "transcend the boundaries of the school day and building" (para. 3). The transcendence of these boundaries is for a collaborative connection between adults and learners, which will lead to an educational transformation (Beattie and Rich, 2018). Specifically, the research partners advocated for an "authentic partnership" between the two groups, which in turn allows for the development of a "fresh mindset that sparks a cultural shift and drives a new kind of action" (Beattie & Rich, 2018, para. 11).

Schumpeter's theory of creative destruction noted "innovation and the entrepreneur" as the basis for capitalism and progress within that economic system (Reier, 2000, para. 5). Moreover, the entrepreneur provides an "impulse for change" (Reier, 2000, para. 12). This entrepreneurial change is afoot in the educational system today, as we move toward what Zhao (2013) calls entrepreneurial PBL.

Schumpeter, more than a century ago, in his initial publication of *The Theory of Economic Development,* explored innovation through entrepreneurship to create opportunities (Ulgen, 2013). However, Schumpeter's (1943) revised version of the book, three decades later, explored the concept of creative destruction. Here, Schumpeter (1943) proposed the disruption of the economy by introducing innovations that seek to make a profit.

While Schumpeter did not investigate the effects of creative destruction on education systems, we are left to wonder how innovation affects the learning ecosystem. Suppose we equate students with profitability, at least in terms of future human capital. In that case, creative destruction theory supports the use of SMEs to increase the alignment

of what schools teach and what business desires of graduates. Moreover, the call for a departure from traditional teaching opens up the potential to "revolutionize the [education] structure from within" (Ulgen, 2013). More specifically, while the literature does not indicate the use of SMEs in Zhao's entrepreneurial approach to PBL, Gordon's (1998) categorization of authentic learning as real-life problems, or authentic PBL as a creative destruction force in education, the research is needed to fill this gap. Conclusively, we are left to wonder if what Perry (2015) called the "Netflix effect" is possible in education through a more authentic PBL ecosystem. Just as Netflix redefined the viewing habits of millions of Americans and put the video rental market into near extinction, can SMEs redefine education so that the 20th-century model of education becomes extinct, as well?

Summary

This literature review described the pedagogical underpinnings of and theories related to an authentic project-based learning experience implemented in K-12 classrooms. Studies that referenced the impact of PBL on student achievement and engagement were reviewed and found positive effects in these areas. Moreover, an exploration of SME use in the classroom was shared. However, the literature indicated gaps in the research related to SME connections in the authentic project learning experiences. Specifically, the use of SMEs in the classroom has primarily been accessed as a lower-level Bloom's approach to understanding with limited information applications.

CHAPTER III

Methodology

Introduction

As explored in Chapter II, the lack of focus on the direct link between authentic learning and project-based learning to improve student outcomes in the K12 setting has created a need to categorize the existing research and determine future research paths. More so, questions remain on how teachers define and implement authentic project-based learning. Tamim and Grant (2013), in a case study of six teachers from varying grade levels and content areas, found teachers understand the premise of constructivist learning but are not equally knowledgeable about project-based learning. Conclusively, a lack of training created a misinterpretation and misapplication of PBL by the teachers (Tamim & Grant, 2013). Ravitz (2010) indicated "no two teachers implement project-based learning the same way" (p. 178). In some instances of "PBL" implementation, teachers require students to create artifacts that do not require higher-level Bloom's thinking (Marx et al., 1997). The lack of fidelity in implementing a pedagogical approach such as PBL may stem from a teacher's desire to increase student engagement while not fully understanding how to implement the chosen pedagogy (Ertmer, 2005).

Tamim and Grant (2013) paid particular attention to the challenges teachers faced when implementing PBL and wondered if constructivist learning's ambiguous nature affected teachers' classroom implementations of PBL. In their case study of six teachers who spanned various grade levels, content areas, and diverse school settings, Tamim and Grant (2013) sought to answer how teachers define and choose to implement PBL. While the sample size was small and not generalizable, a thorough analysis of interview

responses and documents such as lesson plans and assessment instruments revealed teachers use varying degrees of project-based learning to teach content, extend content, or reinforce content. However, each of these approaches' outcomes is often different (Tamim & Grant, 2013).

Very little direct research attention has been given to community partners' and subject matter experts' potential educational ecosystem values. "Working with real-life problems is a sophisticated process that demands refined skills and a tolerance for ambiguity and complexity. While only some teachers and students have an innate capacity for such undertakings, almost all teachers and students can develop such capacity" (Gordan, 1998, para. 26). In their case study, Brown and Edelson (2003) found curriculum use cannot be a recipe to follow. Thus, subject matter experts who direct their attention to creating a curriculum may be better served by directly working with teachers and students.

This study aims to conduct a systematic literature review beyond a general research synthesis but instead seeks to draw conclusions that will recommend policy changes to constructivist education practices, most notably in the arena of authentic project-based learning. This chapter discusses the methodology of the systematic literature review used in this research study. The research questions and the design and instruments of the study are included in this section.

Research Question

The following question will guide this study:

1. How does the systematic literature review process inform the constructivist pedagogical approach to teaching and learning through authentic project-based learning?

Research Design

A systematic review of literature involves "identifying, synthesizing and assessing all available evidence, quantitative and/or qualitative, to generate a robust, empirically derived answer to a focused research question" (Mallett et al., 2012, p. 445). Perhaps less eloquently stated, Grant and Booth (2009) noted a systematic review is about "gathering research, getting rid of rubbish, and summarizing the best of what remains [that] capture the essence of the science of [the] systematic review" (p. 91). As such, a systematic review of the literature is "more rigorous" than a general literature review that accompanies any research study (Cohen et al., 2011, p. 342). This research design type aims to limit bias by "attempting to identify, appraise, and synthesize all relevant studies to answer a question (or set of questions)" (Petticrew & Roberts, 2006, p. 9). The systematic literature review is more structured than a less rigorous traditional literature review, which adds to its credibility (Strukelj, 2018). Cronin et al. (2008) echoed the more rigorous study description and added a "well-defined approach" qualifier (p. 39). Thus, a systematic review of literature is a valuable tool that is a replicable and methodical approach to conducting research (Siddaway et al., 2019).

A systematic review provides wider-reaching effects than a small study, as the synthesis of a broad base of research conducted over several decades produces more

reliable results than a small study done over a few weeks of data collection (Baumeister, 2013). Similarly, unlike a single study that has yet to be replicated, inconsistencies come to light in a systematic review (Baumeister & Leary, 1997; Cumming 2014). Mallett et al. (2012) concurred that systematic reviews provide a focused yet comprehensive coverage of the topic while relying on empirical evidence in a transparent manner that can be replicated in the future. More importantly, as revealed by Bronson and Davis (2012), "when practitioners attempt to read the research literature, they are often left confused about what are considered best practices and with little guidance" (p. 4). Furthermore, the single study approach to making policy and practice determinations is unlikely to reproduce variability across diverse populations, settings, and researchers (Bronson & Davis, 2012).

The systematic review provides the opportunity to connect theory to evidence and create future practice changes (Siddaway et al., 2019). As such, systematic reviews are a "method of mapping out areas of uncertainty, and identifying where little or no relevant research has been done, but where new studies are needed" (Petticrew & Roberts, 2006, p. 2). Notably, the connection between theory and evidence is of great importance. This review seeks to provide a foundational basis for the research question. As a potential result, systemic changes to constructivist pedagogical approaches may occur. These changes could incorporate more authentic designs for project-based learning experiences, including ones that possibly utilize subject matter experts. As noted by Siddaway et al. (2019), this systematic review has the potential to bring enhanced concepts to the forefront of educational policy and practice.

A systematic review attempts to eliminate bias in the research by examining all possible relevant literature related to the research questions stated (Mallett et al., 2012; Siddaway et al., 2019). In fact, Petticrew and Roberts (2006) listed the systematic review as the least biased research type. To reduce the inherent bias ingrained in any researcher, the oft-quoted, sage advice from Bauemister (2013) is to view the systematic review from the lens of a judge and jury trying to determine the facts rather than from that of an attorney trying to manipulate the facts to meet the desired outcome. This impartial review leads to the policy and practice changes that are possible through the systematic review (Baumeister, 2013; Baumeister & Leary, 1997; Bem 1995; Cooper, 2003; Piper, 2013).

The comparison of findings in conflict or the emergence of themes that point to future investigations increases the importance of a systematic literature review (Strkelj, 2018). However, it cannot be ignored that a systematic review begins with publication bias inherently, as there is only the option to review what is published or available online (Piper, 2013). Sandelowski and Barroso (2007) noted published articles might tend toward more positive findings based on current policy trends. In fact, estimates are that only half of the research papers written see publication status (Drucker et al., 2016). Of the fifty percent that see publication, Dwan et al. (2013) concluded that studies that report positive or significant results have greater odds at receiving publication status. More importantly, it is critical to consider that some researchers set out to determine favorable results, as they design a study, pick a population, and test specific interventions based on their potential outcome (Jackson & Kuriyama, 2018).

Mallett et al. (2012) encouraged systematic reviews to include institutional organizations' publications for a wider breadth of applicable findings. Therefore, the

inclusion of literature in this systematic review combined both published journals and "gray literature" that Petticrew and Roberts (2006) defined as that which is not included in databases but extends to conference proceedings, dissertations, white papers, and other unpublished literature (p. 80). The inclusion of this gray literature helped reduce publication bias (Strukelj, 2018). The inclusion of gray literature that is more than a perfunctory search of a database reduced researcher bias and led to an outcome-focused on "evidence, impact, validity, and causality" (Mallett et al., 2012, p. 447). Strukelj (2018) cautioned reviewers, however, to be wary of completing a basic Google Scholar search in addition to a more reputable database. Google Scholar's inclusion of non-peer-reviewed contents has the potential to decrease the credibility of a systematic literature review (Strukelj, 2018).

Participants

The studies chosen for this systematic review were primarily situated at the K-12 level, as needed statewide and federal policy changes were brought to light during the COVID-19 shutdown in education. These changes will perhaps help to foster remote learning improvements that can be translated into brick-and-mortar cultures. While policy changes are also considered at the post-secondary level, many of these changes are dictated on an institution-by-institution basis. Therefore, the post-secondary research was excluded from this systematic literature review.

It is acknowledged that K-12 is a broad range of included studies for review. However, authentic project-based learning applies to the entire K-12 world. In total, these findings are meant to enhance the robust applicability of this systematic review to inform educators better and those responsible for drafting education policy. Furthermore, PBL

enacted across K-12 settings can recommend priorities for advancing PBL research (Condliffe, 2017).

This systematic review did not target a particular subject area for inclusion. “A PBL approach can theoretically be implemented in any area” (Condliffe, 2017, p.5). A limit was not placed on the systematic review's included content areas to obtain the most comprehensive results. Additionally, through the systematic review, an analysis of the various content areas allowed for a better comparison of the research applications of the definitions of PBL and authenticity.

The inclusion of worldwide studies in this systematic literature review was essential to ensure a broader scope of the application of authentic PBL. Project-based learning is not limited to a pedagogical approach practiced in the United States solely. PBL training organizations such as PBL Works (2019) have listed school districts and international education associations as their clients. Comparing the research studies between national and international implementations provided additional depth to the systematic literature review results.

Instrumentation

This review was conducted using the Petticrew and Roberts (2006) Seven Stage Systematic Review Process:

1. Clearly define the question the review sets out to answer
2. Determine the study types to locate
3. Carry out a comprehensive literature search to locate the studies
4. Screen the results to determine if they meet the inclusion criteria
5. Critically assess the included studies

6. Synthesis of the studies to assess heterogeneity
7. Disseminate the review findings

The research question was decided based on the need for a comprehensive exploration of the topic after conducting the cursory literature review for Chapter II.

As a preferable constructivist pedagogical approach, authentic project-based learning was chosen by reviewing educational books published in the last five years (Alper, 2017; Boss & Larmer, 2018, Case, 2017; Christensen et al., 2017; Dintersmith, 2018; Fisher & Fisher, 2018; Grant, 2017; Horn & Stacker, 2015; Kubik, 2018; Larmer et al., 2016; Laur & Ackers, 2017; Markham, 2016; Ross, 2019). Specifically, the theme that emerged from these books was developing authentic challenges supported by a network of experts to establish a more equitable playing field for learners in their post-education opportunities. However, it was noted that these texts did not comprehensively or equally define the application of PBL. Additionally, while supporting the use of subject matter experts, the educational books reviewed rarely provided definitive evidence on why or how to incorporate these professionals in a high-level learning experience. These experts mainly were used as guest speakers on a topic of expertise or as mentors who provided college advice (Alper, 2017; Fisher & Fisher, 2018).

As noted in Chapter II, PBL has not been widely adopted in a standardized form. Moreover, the application of authentic challenges in developing a PBL experience and the use of subject matter experts has been mainly absent from the development of PBL experiences and the implementation of these experiences (Thomas, 2000). Thus, to determine if there is a case for shifting PBL pedagogical practice to encompass a more

direct link to authenticity beyond a simulated experience, the topic and subsequent research question were chosen.

This systematic literature review included research study types of qualitative, quantitative, and mix-methods. No one type was singled out for inclusion based on the desire to develop an all-encompassing review. While there is no definitive percentage of educational studies linked to each of the three study types, Niglas (1999) found in her analysis of British educational publications in the late 1990s that 24% of the studies were qualitative, 35% of the studies were quantitative, and 41% of the studies were mixed-methods.

Haase and Myers (1998) noted qualitative and quantitative methods share the goal of understanding how the world works. King, Keohane, and Verba (1994) posited qualitative and quantitative studies that share a unifying logic that leads to outcomes based on rules of inference. Harden (2010) argued that to make systematic reviews more relevant, the inclusion of both qualitative and quantitative research is required to create a vast net from which the review is conducted that will lead to more evidence and, subsequently, more definitive directions for future policy changes. Thus, this systematic review included qualitative, quantitative, and mixed-methods' studies.

The systematic review began with a search of databases to obtain relevant journal articles. An initial decision to not include a Google Scholar search was made based on Stukelj's (2018) advice that non-peer-reviewed results would be possible. Instead, a focus was placed on databases available through Sam Houston State University's Newton Gresham Library System. The databases searched included EBSCOhost (all databases), JSTOR, SpringerLINK, ScienceDirect, Sage, Wiley Online Library, ProQuest, and

ProQuest Dissertations. Multiple databases were included to ensure as much relevant data as possible was included (Piper, 2013). Additionally, to avoid eliminating potentially critical studies, no time limit on the publication of studies was set (Piper, 2013).

As suggested by Strukelj (2018), the use of Boolean operators "AND," "OR," and "NOT" provided the combinations and exclusions of search results for a more comprehensive return of applicable findings. Additionally, as recommended by Strukelj (2018), the inclusion of truncations when root words were the same was used. For example, authentic and authenticity are truncations with the same root word. Finally, the search for both "project-based learning" and "PBL" was necessitated by the interchangeability of the terms in the professional literature.

Keywords searched followed the prescribed Boolean operator advice for returning the most significant results. As such, the following terms were utilized with the appropriate Boolean Operator: "Authentic" OR "Authenticity" AND "Project-Based Learning" OR "PBL" NOT "Problem-Based Learning" NOT "Higher Education" NOT "Engineering" NOT "Medical." As noted previously, "authentic" and "authenticity" were considered as truncations, as were "project-based learning" and "PBL."

Problem-based learning was rejected as a search option. Problem-based learning utilizes a simulated context that may mirror an authentic situation but does not fully immerse students in a real-world challenge that connects learners to situations outside of the classroom (Jonessen & Hung, 2008). For this reason, "medical" and "engineering" were also eliminated as possible search terms. Additionally, focusing on K-12 studies, "medical" and "engineering" were eliminated as typically university-level courses.

Finally, in an attempt to further focus the return results, “higher education” was included as a “NOT” Boolean operator.

Additional research articles were obtained through suggested reading options sent via email from Academia.edu. These articles were collected from December 12, 2020, through March 12, 2021, with a total of 84 emailed options. The suggested article emails started after accessing Tamim and Grant’s (2013) article, *Definitions and Uses: Case Studies of Teachers Implementing Project-Based Learning*.

Academia.edu (2021) algorithms determine possible articles of interest from previous reading history. Based on the site’s algorithm, the average total of recommended articles is 20 million for users (Academia.edu, 2021). The use of the summary feature on the site offered a systematic selection process of articles to include. The inclusion criteria was based on an analysis of the content to determine if the suggested articles aligned with the goals of this systematic review. However, it is essential to note the free version of the service was used for this systematic literature review. In contrast, the premium, paid service has “advanced research discovery tools” and “enhanced analytics” (Academia.edu, 2021). While Academia.edu is not a conventional online database, Niyazov et al. (2016) found articles uploaded to the site received more citations than those not available on a free site at the rate of 16%, 51%, and 69% more after one, three, and five years respectively.

Table 1 lists the database results for returned articles and includes a total of 743 studies. The initial searches allowed for a more targeted inclusion of specific study-type articles. These studies included both qualitative and quantitative returns, with the majority of the results returned as various types of case studies. All studies included in

this review are classified as peer-reviewed based on their acceptance into a journal, through a conference committee acceptance, or by a dissertation committee review.

Table 1

Database Returns

Database	Results Returned
Academia	84 results
EbscoHost (All databases)	148 results *
Science Direct	33 results
JSTOR	74 results
ProQuest	26 results
ProQuest Dissertations	194 results
Sage Publications	29 results
Springer Link	19 results
Wiley Online Library	136 results

Note: *Remaining results automatically filtered out duplicate results.

Once the initial search of 743 journal articles from the databases was conducted, each article's references' section was reviewed to determine if any additional articles should be included in the systematic review. Four studies for inclusion were found as citations from articles from the initial database searches. There were limited returns from this analysis method as the majority of research utilized for the studies reviewed provided a simplified literature review rather than actual research. With these four studies, the total number of journal articles reviewed was 747 journal articles.

The "critical appraisal" of studies reviewed determined whether or not the articles were "adequate for answering the question" (Petticrew & Roberts, 2006, p. 125). Here, Petticrew and Roberts (2006) recommended considering author bias in studies, including

non-reporting of essential information, method and analysis of the study in question, and how it is presented in a study. The systematic reviewer's selection bias may occur if positive findings are reported over those findings that may not support the desired outcome of the systematic review (Drucker et al., 2016). Therefore, the results of both positive and negative authentic PBL research studies were included in the systematic review.

Transparently, from 2015-2017, I was involved in portions of two studies included in the Science Direct database directly related to the Knowledge in Action (KIA) curriculum (Adams, Lo, Goodell, & Nachtigal, 2017; Lo, 2015). As a PBL National Faculty member for PBLWorks, I participated in training, observing, and coaching teachers utilizing the KIA Advanced Placement (AP) Government curriculum. As both studies returned results in the Science Direct database, they were kept as part of the systematic review. These two studies were included for analysis to compare to the other emerging themes of the studies reviewed.

A further critical assessment of the studies, as indicated by step five of Petticrew and Roberts' (2006) Seven Stage Systematic Review Process, is located in Chapter IV of this systematic review of the literature. Here, the themes developed from the review will be included. Likewise, step six, which assesses the heterogeneity of the studies and provides a synthesis of the studies, is found in Chapter IV. Step seven, the review of the systematic literature review is provided in Chapter V.

Data Analysis

As a mixed-methods study, the data was analyzed through quantitative and qualitative methods. The two approaches to research are combined for this study to develop a more holistic view. This view seeks out the potential impact that the research outcome can have on the design and implementation of authentic PBL challenges in a K-12 setting, especially those that may utilize SMEs in the design and implementation process in the K-12 classroom.

Extensive research studies have been conducted on why a mixed-methods approach is preferable to a single focus for data collection. Qualitative and quantitative researchers often find themselves at odds with one another, but as Onwuegbuzie and Leech (2007) demonstrated, a mixed-methods approach better supports the social sciences. Further, mixed-methods provide a researcher with the possibility to strengthen their findings and provide a more detailed look at the investigation in question (Kelle, 2006). Brannen (2005) further cited detailed trends in a call for moving toward a combined effort of approaches and noted that researchers typically form habits of preference rather than becoming skilled at both qualitative and quantitative approaches. Additionally, Brannen (2005) found that qualitative research is only concerned with the interpretation of words and meanings, while quantitative research focuses on the numbers and behavior of the population samples studies are, in fact, overly simplified ideas. She further explained the statistical inference power of quantitative research could be matched by the ability of qualitative findings to be generalized to the other settings (Brannen, 2005).

Qualitative studies have the power to produce information about behaviors and processes of why a pedagogical approach was successful but not whether or not the research study worked (Petticrew & Roberts, 2006). To establish if a research study worked, a quantitative approach is appropriate, leading to the determination that in conducting a systematic review of the literature, one does not need to make an "either/or" choice between qualitative and quantitative inclusion (Petticrew & Roberts, p. 59).

A narrative synthesis of the systematic review is appropriate for a social science topic when it is difficult to include homogenous studies solely (Petticrew & Roberts, 2006). A tabulation of the studies that include a description of the studies, their populations, methods, and results is appropriate to understand the overarching synthesis is the first step in determining the accompanying commentary (Petticrew & Roberts, 2006).

To determine the inclusion or exclusion of the database return results, several factors were considered. The first step in this process was to record every study title in a Google Form. The reason for including these titles was to ensure that if an access session timed out, the studies in question could be found. Next, a review of the study titles was conducted to determine if any study could be immediately eliminated for reasons related to the exclusion criteria listed in Table 2. For example, if a title included "nursing" or "tips for implementing PBL," it was coded as an eliminated study. Next, the remaining study abstracts were read to determine the initial inclusion or exclusion criteria. Again, keywords were targeted for immediate exclusion for the review such as "university-level" and "professional development." If the abstracts did not include an exclusion criteria

keyword, the entire study was read to determine its applicability to the systematic review.

The exclusion results are included in Table 2 and provide the broad categories of rejected studies. The matrix of Table 2 lists the elimination categories on the vertical column and the databases on the horizontal row. As previously mentioned, any studies related to engineering or medical school were immediately eliminated due to their close tie with problem-based learning rather than project-based learning. Additionally, these two categories have a higher education focus and were not germane to this systematic review. Even though the Boolean search attempted to eliminate these articles, upon further analysis of the studies, the search did not extract them from the results altogether. Article returns that provided tips and tools for implementing authentic project-based learning were eliminated. These returns were not focused on a project but instead on how to potentially implement a project. Returns that included opinion-only articles were eliminated as biased pieces. Additional articles that were removed included designing PBL spaces, how-to instructions for implementing PBL, teacher training outcomes for PBL, technology-focused outcomes for PBL, and proposed frameworks for PBL success. Several returns that were non-germane to the study included the effects of National Board Certification in the classroom, evaluations of program implementation, and professional development impacts on classroom integration of pedagogies.

Table 2

Database Returns Elimination Categories

	Aca-demia	Ebsco Host	Science Direct	JSTOR	Pro Quest	ProQuest Diss.	Sage	Springer	Wiley
Admin	0	1	1	2	0	17	0	0	1
After-school	0	0	1	1	0	6	0	0	2
Barriers	0	4	0	1	0	3	2	0	1
Benefits	4	5	1	1	0	15	1	0	7
Higher Ed.	22	11	6	5	14	14	3	1	18
Framework	17	2	2	7	1	12	0	5	18
Non-germane	18	3	2	2	3	15	3	6	14
Opinion	0	3	0	2	0	0	2	0	8
Outcomes	4	1	1	0	0	33	1	1	5
Overview	0	1	0	0	0	0	1	0	2
Tech Focus	0	2	0	0	0	8	2	2	5
Tips & Tools	6	51	6	26	1	62	5	2	33
Training	3	9	0	2	1	9	1	0	4

The initial data collection from the reviewed studies were placed into Google Sheets for formatting of important information. Studies were color-coded for ease in later location and appropriate analysis. Initially, acceptable studies were left as a white or no-fill for the cells. A deeper analysis of the accepted studies created additional categories for color-coding. Gray was assigned to dissertations and theses as gray literature. Yellow was assigned to one university study that was significant for the review. Peach was

assigned to studies that, upon initial review, were detailed authentic project learning experiences and connected to a subject matter expert. Pink was assigned to studies that were initially questionable and needed further analysis. Green was given to studies that were duplicates across databases. Based on the categories listed in Table 2, immediately rejected studies from the title information were coded as red. From the categories listed in Table 2 studies that were rejected after reading the abstract were coded as purple. Related to the categories listed in Table 2, studies that were rejected after reading a significant portion of the study were coded as blue. Table 3 shows the breakdown of the color-coded rejected articles.

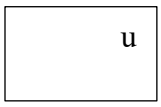
Table 3

Accepted and Rejected Article Categories

	Aca-demia	Ebsco-Host	Science Direct	JSTOR	Pro-Quest	Pro-Quest Diss.	Sage	Springer	Wiley
White/ Accepted	5	30	10	22	6	0	9	2	13
Gray/ Gray Lit.	0	10	0	0	0	14	0	0	0
Yellow/ Higher Ed.	0	1	0	0	0	0	0	0	0
Peach/ SME	1	12	3	3	0	0	0	0	4
Green/ Duplicate	6	2	1	1	0	0	0	0	1
Red/ Rejected Title	35	44	9	17	9	73	4	5	17
Purple/ Rejected Abstract	21	28	5	23	7	104	14	11	89

(continued)

Blue/ Rejected Study	16	21	4	9	4	3	2	1	12



After completing the elimination analysis of returned results, 145 studies remained for further examination and evalation. Table 4 contains the included results returned by the databases. EbscoHost and JSTOR, the two databases with more significant returns also netted a higher number of included studies. However, Wiley Online Library and SpringerLink, two databases that returned high initial results, had comparatively low returns for included studies. When adding the four studies from the reviewed references section, 149 studies in total were included for the analysis in Chapter IV.

Table 4

Database Returns Included

Database	Included Results Returned	Duplicate Returns
Academia	6 results	6 within
EbscoHost (All databases)	55 results	2 across (JSTOR, Wiley)
ScienceDirect	13 results	1 across (EbscoHost)
JSTOR	22 results	1 across (EbscoHost); 2 within
ProQuest	6 results	0
ProQuest Dissertations	14 results	0
Sage Publications	9 results	0
SpringerLink	2 results	0
Wiley Online Library	18 results	1 across (EbscoHost)

Each database was assigned its own tab in the Google Sheet. Information was then entered into the Google Sheets for each of the accepted and questionable studies including the basic notations of study type, grade level, content area, and, if applicable, international studies. The studies' provided definitions for PBL and authenticity were separate categories of included notations. A detailed description of the project was recorded and outcomes of the studies were also included in this section. The Google Sheet also included a category for the use of an SME, and, if an SME was included in the project, a detailed account of their participation was noted. Finally, any unusual or interesting information that was included in the studies was noted in the Google Sheet. This type of information included the use of the words, "activity" or "lessons" in conjunction with PBL.

Summary

A systematic review of the literature, while extensive, cannot be exhaustive. "Knowing when to stop reviewing the literature is as important as knowing where and how to locate sources" (Merriam & Tisdell, 2016, p. 94). This systematic review of the literature sought to find the potential connections between teachers, learners, and subject matter experts in a constructivist pedagogical framework aligned with authentic project-based learning. A total of eight widely-referenced education databases were consulted, and one automatically recommended source for articles was used to review the literature systematically. Once it was recognized that the literature reviewed contained many of the same references listed in multiple studies, the saturation point discussed by Merriam and Tisdell (2016) was reached. However, it must be noted that the warnings by Mallett et al.

(2012) were considered where the broad review principles were followed while allowing for some flexibility in tailoring the process with a relatively uncharted study topic.

CHAPTER IV

Results

Introduction

This chapter discusses the analysis of the reviewed literature from Chapter III. Following Petticrew and Roberts' (2006) Seven Stage Systematic Review Process, this chapter encompasses a further critical assessment of the included studies. A synthesis of the studies to assess their heterogeneity is also explored. Here, Carnwell and Daly (2001) proposed four approaches to framing the results of a systematic literature review. In evaluating the studies returned in this systematic review, the logical approach for this analysis required a division of the literature into themes. This thematic approach is the most popular type for systematic literature reviews (Carnwell & Daly, 2001). In addition to findings of conflict, these themes are the core importance of the systematic review (Strkelj, 2018). This thematic approach to the review allowed for a more comprehensive inclusion of contradictory data, limitations of the studies, and applications of the results for the discussion in Chapter V.

Research Question

The themes culled out from the systematic review of the literature answered the following research question:

How does the systematic literature review process inform the constructivist pedagogical approach to teaching and learning through authentic project-based learning?

Data Analysis Through Three Themes

An important factor in determining the themes for categorizing the returned study results is a reiteration of a lack of a standard PBL definition and application in the literature (Jonessen & Hung, 2008; Condliffe et al., 2017). The loose definition of PBL, provided by Markham et al. (2003), as an extended instance of inquiry learning aligned to standards, was used for this systematic review. Still, the degree to which the reviewed studies applied this definition varied. More specifically, this review also utilized Thomas' (2000) five distinguishing features of PBL to determine the category to which each study was assigned: centrally embedded in the curriculum, the inclusion of a driving question or problem about the curriculum, requirement of an investigation into the curricular concepts, allowance for student-driven approaches rather than teacher-scripted ideals, and a real-world rather than a simulated or textbook focus.

BIE, now PBL Works (2019), was frequently cited in the reviewed studies as a metric by which researchers defined PBL. Sustained inquiry, an element of PBL noted by PBL Works (2019), was a recorded, stand-alone defining component of PBL stated by some researchers (Anderson, 2011; Chu, 2009; Clemmons & Sheehy, 2011; Gebre & Polman, 2020; Gkiolmas et al., 2020; Hammett & Dorsey, 2020; Hamzeh, 2018; Harris et al., 2015; Keen & Kwe, 2014; Lattimer & Riordan, 2011; Makaramani, 2015; Miller, 2013; Mukhambetova et al., 2019; O'Neill & Polman, 2004; Price et al., 2019; Togia et al., 2014). Constructivism was the other most commonly cited PBL definition (Archana & Darasawanh, 2017; Baytak & Land, 2011; Blanchard et al., 2010; Boardman et al., 2017; Hsu et al., 2014; Hung & Tan, 2004; Furco, 2010; McKoy et al., 2015; Moje et al., 2001; Ortiz & Keim, 2017; Torres & Rodriguez, 2017). However, as applied by several

researchers, the general implementation of PBL does not necessarily equate with deeper levels of thinking in which students engage in authentic, relevant, and complex challenges connected to the community (Petraglia, 1998; Roach et al., 2017). Here, the Newmann et al. (1996) explanation of authenticity as "construction of knowledge, disciplined inquiry, and value beyond school" was utilized for the studies' placement into the themes (p. 282). Notably, the applied definition of authenticity in the reviewed studies paralleled the lack of fidelity to a PBL definition. In some cases, authenticity was mentioned but not defined by the authors of the studies (Bittel & Hernandez, 2006; Bitz & Emejulu, 2015; Clemmons & Sheehy, 2011; Essa et al., 2012; Green, 1996; Hamzeh, 2018; Harris et al., 2015; Hellebrandt, 1999; Hsu et al., 2014; Johnson et al., 2019; Kemker, 2007; LeBlanc et al., 2015; O'Neill & Polman, 2004; Palatnik & Koichu, 2017; Peters et al., 2019; Price et al., 2019; Rowe & Probst, 1995; Savinovich, 2018; Seraphin, 2010; Smith & Pastor, 2016; Spires et al., 2016; Swingle, 2019; Togia et al., 2014; Vellom & Pope, 2000; Vincente et al., 2021). Tables 5 and 6 show the distribution of PBL and authenticity definitions provided by the reviewed studies.

Table 5

PBL Definition Distributions

Definitions	Theme One Extended project-like activities	Theme Two Academic projects with limited inquiry	Theme Three Authentic project-based learning experiences
Blumenfeld et al. (1991)	5	4	0
Challenge-Driven	5	2	3
Constructivist	6	4	1

(continued)

Complex-Sustained Tasks	2	8	0
Higher-Order Thinking Problems	3	2	3
Inquiry-Based	4	7	4
Interest-Driven	5	4	1
No Definition Provided	8	24	15
PBL Works	5	4	1
Real Issue in the Community	1	5	3
Thematic Activities	4	2	0
Total Studies	48	66	31

Table 6

Authenticity Definition Distributions

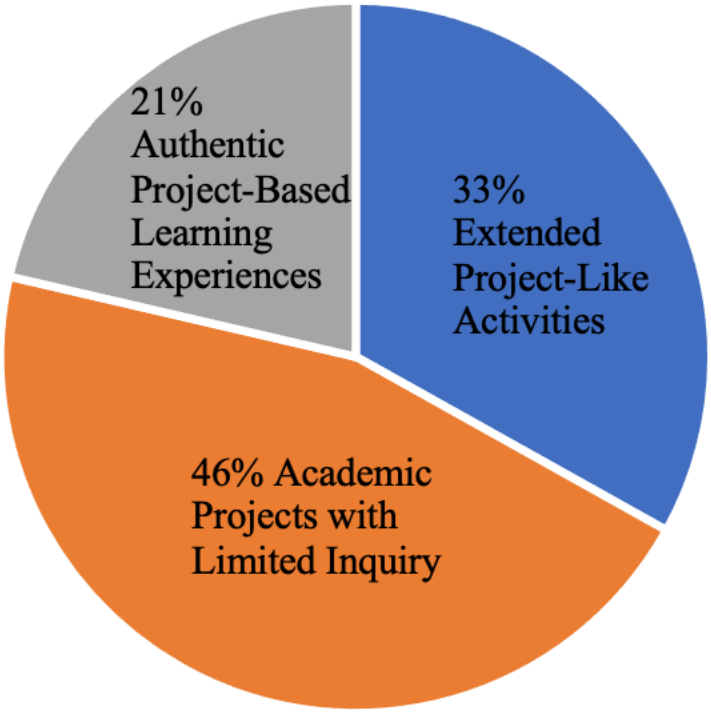
Definitions	Theme One Extended project-like activities	Theme Two Academic projects with limited inquiry	Theme Three Authentic project-based learning experiences
Community Connections	8	9	12
Expert-Like	5	7	2
Newmann et al. (1996)	8	8	9
No Definition	12	11	2
Purposeful	0	3	1
Relevant	6	7	3
Real-World Simulation	8	21	0
Useful	1	0	2
Total Studies	48	66	31

Initially, Zhao's (2012) classifications of PBL into academic, mixed, and entrepreneurial categories were considered as possible themes for this systematic review. The academic PBL approach has specific content and skills determined and evaluated by the teacher's design, while the entrepreneurship lens emphasizes a final product meant to solve a challenge for an external audience of consumers (Zhao, 2012). In the mixed category, a combination of teacher-designed, content-specific projects with some elements of entrepreneurial PBL creates a sense of challenge while allowing the teacher to maintain tight control over the learning process (Zhao, 2012). However, upon further investigation, these three categories were not entirely appropriate as the themes that emerged from the systematic review.

The systematic review results showed that the level of implementation of the required elements of PBL and the application of authenticity differed from study to study. In some studies, the lack of a definition of authenticity was problematic. In other studies, the "PBL" experience design was not consistent, even with noted similarities in the studies' given definitions of PBL. This lack of consistency in implementation and application led to categorizing three overarching themes: extended project-like activities, academic projects with limited inquiry, and authentic project-based learning experiences. A more detailed description of the projects was reviewed within the three themes, with themes two and three having two specific sub-categories: inclusion of SMEs and exclusion of SMEs. The overall percentage breakdown of the three themes is presented in Figures 2 and 3.

Figure 2

The Breakdown Percentage of Themes

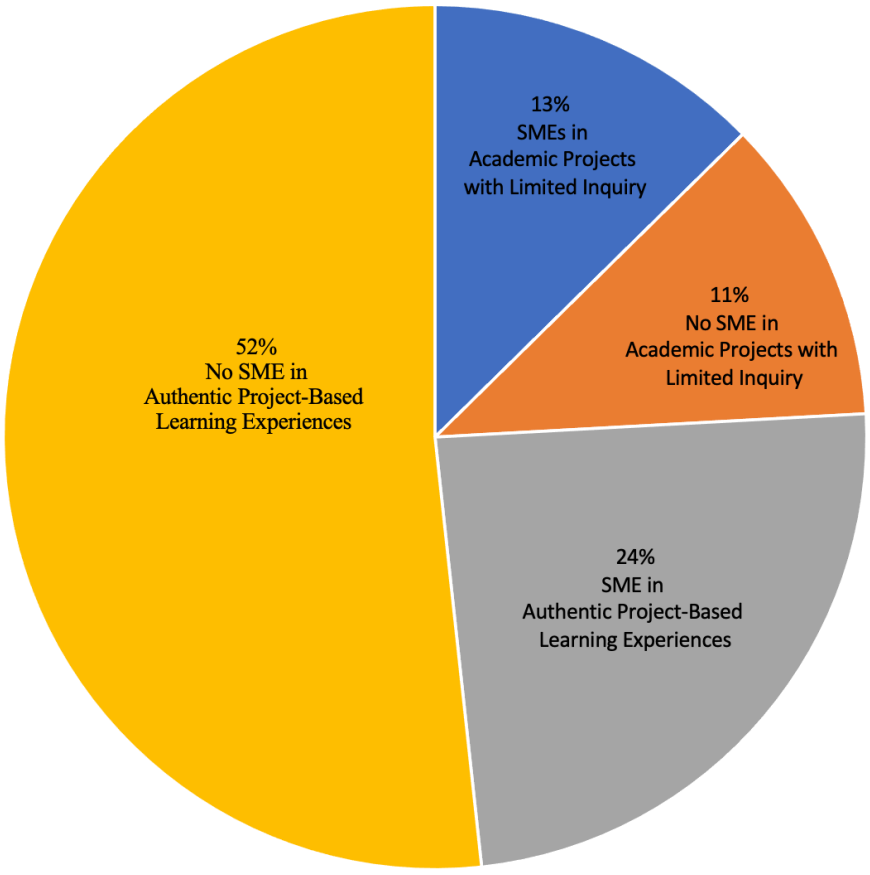


A thematic synthesis was chosen to interpret the results of the collected data. According to Thomas and Harden (2008), the thematic synthesis approach appraises the appropriateness, acceptability, and effectiveness of the studies included in the systematic literature review. Each study included for analysis was assigned a theme initially, using a color-coding process within the spreadsheet of collected studies, to ensure consistency within the categorization of the themes. Theme one was coded as white. Theme two was coded as blue for non-SME studies and purple for studies that included SMEs. Theme three was coded as pink for non-SME studies and tan for studies that included SMEs. Once the thematic synthesis started, each study was re-reviewed to ensure the appropriate

categorization. Upon the reassessment, seven studies were re-classified into new categories. The thematic synthesis created "conclusions based on common elements across otherwise heterogeneous studies," a strength of the thematic synthesis approach noted by Lucas et al. (2007, para. 25).

Figure 3

Breakdown Percentage of Sub-Themes



Theme One: Extended Project-Like Activities

As the father of the Project Method, the leading methodology preceding PBL, Kilpatrick (1918), astutely noted, over a century ago, that we must answer the question, "...does the term 'project' fitly designate the waiting concept?" (p. 319). Kilpatrick (1918) admitted that he did not invent the term "project," however, he boldly called out those who were using the term generally and in a "mechanical and partial sense" (p. 320-321). While the studies that fit into theme one designated their "projects" as "PBL" experiences, upon completing detailed reviews of each study, it was evident that the researchers in question did little more than merely complete a checklist of PBL elements. There was a lack of thorough evaluations of the learning experiences in question. The theme one studies aptly fits into what Kilpatrick (1918) stated as a teacher's inability to "discriminate between drill as a project and drill as a set task" (p. 334).

Gordon (1998) described academic challenges as ones that educators craft from existing curricular materials into a problem format with teacher-led structures. This academic challenge, according to Gordan (1998), can be an entry point into PBL. However, the projects listed in theme one often fell short of the academic challenge description. Some project descriptions did not include a challenge but instead focused on lower-level Bloom's information that generally fell into the knowledge, understanding, and application levels. Additionally, many researchers' studies that fell into this theme utilized a checklist of PBL elements without evidence of how those elements were met within the project. In some instances, no definition of PBL was provided in the study with only a mention of the pedagogical approach (Bittle & Hernandez, 2006; Garran,

2008; Hellenbrandt, 1999; Huizenga et al., 2009; MacArthur et al., 2002; Smith et al., 2016; Taylor & Stuhlmann, 1998; Turnball, 1999).

Short Activities

The range of activities classified by researchers as authentic PBL in theme one varied greatly. On the lowest end, Wengerd (2010), in her phenomenological case study, had her learners find the length of objects in the classroom. Interestingly, Wengerd (2010) applied a different PBL definition to her research than any other study reviewed. Wengerd defined PBL as "preparing students for the real world through an active process that teaches critical thinking, problem-solving, teamwork, negotiation skills, consensus building, technology, and responsibility for one's own learning" (p.1). This definition aligns with the measuring activity, but it does not align with the inquiry-based definition of PBL from Markham et al. (2003).

Parallel to Wengerd's (2010) measuring activity, although from a high school geometry lens, Choo et al. (2009) had students complete geometry problems online collaboratively. However, Choo et al. (2009) used a much different definition of PBL and described it as a "stress on the value of useful contribution or service while learning" as students "create, relate, or donate" while doing something authentic (p.16). Revealingly, Choo et al. (2009) used the word "activity" to describe the study's project, which did not improve students' understanding of geometry and found that some students refused to participate extensively.

The extended activity on creating the largest number of pizza slices in a pie used the Blumenfeld et al. (1991) definition of a PBL experience in a case study completed by Palatnik and Koichu (2017). Here, the pizza activity does require making predictions,

drawing conclusions, and communicating ideas with others, as Blumenfeld et al.'s (1991) PBL definition requires. However, while students did increase their understanding of algebra concepts through this activity and other similarly designed problems, Palatnik and Koichu (2017) referenced the learning experience as a series of "activities" even though they also coined the lessons as PBL.

Student Choice

A review of Bittle and Hernandez's (2006) study on how PBL creates improved student course grades found that when given a choice of projects based on levels of Bloom's, 98% chose higher-level thinking projects. Additionally, 79% of those students selected to complete an "A-level" project, and 57% of those students earned the "A" grade (Bittle & Hernandez, 2006). While we could use this study as support for increasing the use of authentic PBL in an inquiry-driven classroom, the types of projects that were part of the choice menu do not meet the definitions of either authenticity or PBL. An evaluation of the astronomy used in a movie or an improved solar system model compared to that of the textbook is little more than extended activities (Bittle & Hernandez, 2006). Thus, Bittle and Hernandez (2006) have a questionable understanding of PBL and did not define either PBL or authenticity within the study.

At the elementary level, Chard's project approach was used when first-grade students were given the choice of what to study: frogs or dinosaurs (Bryson, 1994). According to Bryson (1994), the learning experience was authentic based on student choice. However, Bryson (1994) provided no other definition of authenticity. In this case study, the teacher noted she could have more explicitly included math concepts to increase the level of authenticity (Bryson, 1994). For instance, two boys studied how

far frogs jump but did not complete a graph to show their findings (Bryson, 1994). Thus, the inquiry was limited from the project description, and there was a focus on low-level Bloom's information.

Taylor and Stuhlmann (1998) completed an early elementary case study that found students to have improved communication skills and a better appreciation for their state culture. With no definition of PBL provided in the research, students merely participated in an activity in which they communicated in an online forum with teachers pretending to be characters from an assigned book (Taylor & Stuhlmann, 1998). Johnson et al. (2019) explored life in other countries using the five senses in a kindergarten classroom case study. The "authentic" product was a FlipGrid video on which parents could comment.

Real-World Roles in Hypothetical Situations

Several projects within theme one were touted as authentic when real-world roles merely inspired the activities. The Egyptological excavation and scrapbook project required students to pick two locations to virtually excavate, craft two artifacts, and journal about their pretend experience as a Roman emperor (Garran, 2008). Garran's (2008) study used Newmann et al.'s (1996) definition of authenticity and never defined PBL even though the study's title included a PBL reference. In fact, the author noted that the project experience was conducted primarily outside of class (Garran, 2008). This homework approach to the project indicated little pedagogical forethought for classroom implementation but was instead an add-on extended homework experience. More importantly, the goals for the project, which the author noted were reached, have no reflection on a PBL design. These project goals included a) an analysis of primary and

secondary sources; b) the development of research skills and bibliographic formatting; c) understanding the methods of archeologists; and d) understanding of the use of artifacts by historians (Garran, 2008).

Using the BIE (PBL Works) definition of PBL, Hill (2014) designed an interdisciplinary project to entice her learners to engage in planning a fictional band tour to enhance their literacy and math skills. Students had to produce press releases, pen television and radio spots for advertisements, and calculate the tour costs as they mapped out the city stops (Hill, 2014). The result of the tour planning was that not as much time was spent as in previous years reteaching concepts for the final exam (Hill, 2014). However, with the fictionalized approach and final in-class presentation to their peers, opportunities were lost to go beyond a let us pretend process (Hill, 2014).

Davis and Wendelyn (1998) partnered with a school in Russia to connect their students in Washington in a collaborative endeavor to solve a hypothetical problem. The researchers classified this learning experience as project-based learning since the students created something new that had a solid academic component (Davis & Wendelyn, 1998). However, the case study solution reads like a problem-based learning experience rather than a project-based experience. Students, acting as medical doctors, were merely presenting their solutions to whether or not Princess Adelaide suffered from whooping cough (Davis & Wendelyn, 1998).

Establishing a martian colony was the focus of Smith and Pastor's (2016) project design. Through their participation in this hypothetical problem, the duo found that high-achieving students learned to be more creative and take greater risks (Smith & Pastor, 2016). In contrast, traditionally lower-achieving students discovered they could apply

their knowledge in practical situations outside of the classroom (Smith & Pastor, 2016). With no definition of PBL or authenticity provided in this study, the project aligns with an extended activity rather than a true authentic PBL experience.

Unlike Smith and Pastor (2016), Inserra and Short (2013) provided a clear definition of PBL that included a driving question that students attacked cooperatively to solve. Although similar to Smith and Pastor (2016), Inserra and Short (2013) focused on presenting students with hypothetical problems to solve and did not include a focused definition of authenticity. The results of a one-way ANOVA test indicated that social studies teachers, using a one-to-one computing environment, utilized PBL pedagogical practices that focused on higher-order thinking skills more so than math teachers in a one-to-one computing environment.

Cultural Awareness

A cultural understanding was an authentic focal point of a portion of the first theme's projects and, as such, was labeled as the real world. Makaramani (2015) attempted to increase student awareness of global issues and appreciate diversity between the Mongolian and Thai cultures and had students utilize Google Hangouts to communicate and teach each other to make a traditional dish from their country. Makaramani (2015) revealed that the project outcomes reached 100% effectiveness in meeting the eight essential elements defined by BIE (now PBL Works). The level to which this project was implemented using the BIE's essential elements of PBL comes into question. While authentic food was part of the project, the level of inquiry into a central challenge was non-existent.

Like the design of Makaramani's food demonstrations, Kean and Kwe (2014) crafted a project on the cultural folk dances in Japan. However, Kean and Kwe (2014) recognized the limitation of the authenticity of their project as it scored 55.6% authentic using Jonassen's (1991) authenticity rubric. Although the pair determined the exploration of cultural folk dances was enough to align their project with the definition of PBL used by PBLWorks, they did not provide evidence of the alignment (Kean & Kwe, 2014).

Scripted Situations

Harris et al. (2015) found that project-based inquiry science (PBIS) classrooms scored higher on unit tests when working on projects developed by SMEs. However, these projects did not require students to solve an authentic challenge but instead had them solve a scripted problem (Harris et al., 2015). Thus, Harris et al.'s (2015) use of PBIS is perhaps better aligned with PrBL than PBL. Moreover, one of the nine authors of the randomized control study, Joseph Krajcik, was listed as a co-author on numerous scientific studies which tended to be better aligned with PrBL than PBL with limited inquiry opportunities (Short et al., 2008; Crawford et al., 1999; Novak & Krajcik, 2019).

An elaborate simulation of the bartering system was developed by SMEs, who were tribal elders, artists, and academics, to implement a K-8 art program in a tribal school (Bequette, 2014). SMEs were tapped to design the program for the tribal school as it was determined that white teachers were ill-equipped to understand the inner workings of the tribal barter system (Bequette, 2014). Mirroring cultural work such as carving a canoe resulted from this SME-designed learning activity that did not align with Markham et al.'s (2003) definition of PBL. However, it was noted that the learning experience was better aligned to tribal culture than the more culturally insensitive dreamcatchers and

beadwork that white teachers had previously taught (Bequette, 2014). The mixed-methods study proved that 75% of the tribal school teachers trained in PBL did not continue implementing projects after the SME-designed lessons were finished (Bequettee, 2014).

Vincente et al. (2021) analyzed the increase in students' understanding of programming and sustainability in a STEAM PBL experience and found a 60% increase. While this 4th, 5th, and 6th-grade learning experience explored a real-world topic in creating a sustainable city, the activity that resulted from the idea merely had students activate sustainable components of a city block with a programmed robot (Vincente et al., 2021). This application of students' knowledge did not delve into how making their community more sustainable could have been used as a scaffold for a more authentic project-based learning experience.

In cases such as Huizenga et al. (2009), students played a game simulation as the project experience to increase engagement, motivation, and learning. Huizenga et al. (2009) compared the PBL classroom that used the game to a non-PBL classroom but did not define PBL in their research. While classified as PBL by Huizenga et al. (2009), the game simulation was an application-level Bloom's extended activity by definition.

Another instance of an opportunity to use a scaffolded experience for a potential authentic challenge was seen in the MacArthur et al. (2002) study that found student engagement increased in a sixth-grade social studies class when students were allowed to debate controversial topics. However, overall, the researchers found that students used fewer academic debate defenses and settled on everyday argument commonalities (MacArthur et al., 2002). The immigration debates discussed in the study could have

been a scaffolded activity to develop a plan to create policy for the current American immigration situation (MacArthur et al., 2002).

Archana and Darasawanh (2017) saw improved English skills with English as a Second Language (ELL) students. In this case study, students had to identify problems but did nothing to solve them (Archana & Darasawanh, 2017). While some of the lack of in-depth inquiry and higher-level Bloom's implementation may have been due to the language barrier, the classification of PBL here is suspect as the authors only mentioned PBL as a constructivist approach to teaching and learning (Archana & Darasawanh, 2017). In Ratminingsih's (2015) case study of ELL students in a PBL classroom, using personal photographs taken during a field trip improved the English of the Indonesian-speaking students. The students indicated they enjoyed the PBL approach, and their writing skills also improved, but the descriptive use of the PBL in the case study comes into question (Ratminingsih, 2015). The researcher qualified this extended activity linked to the field trip as PBL because it was a student-centered approach to learning (Ratminingsih, 2015).

Low-Level Bloom's Summative Products

Designing a poster board or videos to share with the class was a typical theme one project type. However, these learning artifacts focused on lower-level Bloom's information that was showcased in a format other than a traditional research paper. Yazdanpanah (2019) designed four PBL "lessons" on culture that resulted in a choice of a poster or video to either show teens how to complete an activity or analyze a commercial geared toward teens. Chu's (2009) labeled inquiry-based PBL experience merely had students create a PowerPoint presentation or, as an alternative assessment, a cartoon on

the history of Hong Kong. Gebre (2018) evaluated student understanding of nutrition through creating infographics. Here, student understanding may have been affected by using a professional journal editor (Gebre, 2018). However, the information included in these projects was limited to lower-level Bloom's thinking.

Fine (2018) noted that students must participate in activist-type events to be engaged in an authentic PBL experience. However, in the 100 hours Fine (2018) spent observing teachers and learners in his ethnographic study, students produced low-level work. Summative products included examples such as documentaries that were shown only to the class and did not solve an actual problem, or the products resulted in hard-to-measure events such as sit-ins. At the elementary level, DeCarlo et al. (2018) used a community-helper theme in which students produced voice recordings using the Little Bird Tales app to explain to listeners what made their city special.

Several studies found improvements in test scores even with project-like activities. Cervantes (2013) found an improvement on the Texas state test, STARR, in both reading and math for seventh and eighth-grade students when implementing a PBL approach to teaching. Specifically, students generated artifacts on topics covered rather than traditional worksheet practice assignments (Cervantes, 2013). Turk and Berman (2018) found that student results on the New York Regents state exam improved when students explored how to create a successful protest movement when studying the 1950s in history class. At the request of the teachers, rather than through an inquiry-led process, students created pamphlets with information that they placed in grocery stores (Turk & Berman, 2018). The duo noted the students were acting as historians in this project even

though the information included in the pamphlets was lower-level Bloom's in nature (Turk & Berman, 2018).

Short et al. (2008) found an increase in student understanding of three of five subareas of the content studied in a learning experience in which high school chemistry students explored how geckos stick to objects. Students completed an essay at the end of the exploration, and pre and post-test results showed significant gains with $p<0.001$. However, this research and report findings approach to the learning experience call into question how driving questions are formulated and at what level of Bloom's PBL should be categorized.

Activities with an Inauthentic Audience

Students presenting researched information to a younger grade were considered a public audience by Price et al. (2019). According to the research team, this week-long experience met the elements of PBL as defined by PBL Works (Price et al., 2019). However, the information included was relegated to low-level Bloom's content. Baytak and Land (2011) used the same approach of older students presenting information to younger grades as qualifying as an authentic audience.

Hamzeh (2018) also concluded that a public presentation was necessary to meet the elements of PBL. Here, again, we see a theme one emergence in a math project that focused more on direct instruction than on inquiry (Hamzeh, 2018). Conclusively, in semi-structured interviews, Hamzeh (2018) recorded that the teachers involved in a modified math PBL approach believed not all students could achieve higher levels of thinking even though more traditional performance tasks were included.

Foreign language classrooms that fell into theme one produced mixed outcomes. In a Spanish two classroom, speaking skills improved when students interacted via email with experts from a Pro-Pueblo movement organization in Ecuador (Hellebrandt, 1999). However, students were only required to produce web pages sharing the information about the organization and the movement rather than providing possible solutions for the social justice issue (Hellebrandt, 1999). Conversely, after conducting 400 minutes of classroom observations in a French one class, researchers found no improvement in attitudinal or cultural objectives (Turnball, 1999). In fact, teachers noted they spent more time explaining directions on how to complete activities than they did on speaking French (Turnball, 1999). In both cases, neither Hellebrandt (1999) or Turnball (1999) provided a specific definition of authenticity, nor did they define PBL.

Theme One Concluding Thoughts

Teachers have used the revised Bloom's taxonomy to design learning activities and assessments of those learning activities since 2001 (Stanny, 2016). The extensive use of verbs to describe the six levels of Bloom's was found by Stanny (2016) to have duplicated results over two or more levels in 46% of the verbs used. Thus, the application of Bloom's to theme one in this systematic literature review parallels the findings by Stanny (2016). "The lack of consistency in how lists align verbs with levels of thinking reduces the value of these collections as frameworks … to describe lower- and higher-order thinking skills" (Stanny, 2016, p.49). Conclusively, driving questions that asked students to create a poster, pamphlet, or video in theme one cannot be considered at the creation level of Bloom's but rather fall into lower levels of thinking in the taxonomy. Additionally, identifying problems without solving them does not meet the creation level

of Bloom's, nor does following the steps in a scripted problem offered by the teacher. To reach higher levels of Bloom's deeper thinking and engagement in inquiry must be present. When paired with real-world issues, learning outcomes strengthen higher-order cognition, which improved in theme two but was not fully realized (Madhuri et al., 2012).

Theme Two: Academic Projects with Limited Inquiry

Inquiry can challenge us to change how we think about ideas on "how people work, how change happens, and how research can contribute to this process" (Reed, 2007, p. 2). The process that we call "inquiry" is a "natural human and social endeavor that confirms or elaborates existing knowledge and can generate new knowledge" (Rallis & Rossman, 2012, p. 6). More importantly, inquiry requires us to ask questions rather than to take information at face value as we "think differently about what we thought we knew or what we claimed we thought we knew" (Rallis & Rossman, 2012, p. 6-7). Well-designed authentic PBL experiences have the opportunity to enhance a learner's ability to engage in the inquiry process as they pose questions to an open-ended challenge. However, theme two's categorized projects impeded the inquiry process on various levels ranging from telling students a process to follow or simply crafting a research paper in disguise that went into higher levels of Bloom's than theme one's extended activities.

Collins et al. (1991) discussed "cognitive apprenticeship" as another model of PBL for teaching in which students: "(a) learn the 'crafts' of subject matter areas such as mathematics, writing, and reading in the identical context that they would be expected to use these skills in later life; (b) receive a large amount of practice; (c) learn from experts who would model the skills and then give feedback to students as they practice them; and (d) receive an emphasis on the acquisition of metacognitive skills useful for applying the

to-be-learned skills" (p. 462). However, this approach is often relegated to emulating the work of a professional.

No SMEs: Working as a Professional

In Rasori's (2009) study of her personally-created PBL curriculum, students "became" historians in their quest to connect historical concepts to problems of today (p. 14). However, upon further inspection, the learners merely had to study a historical figure, determine how that figure impacted history, and present their findings on a poster board with an accompanying essay (Rasori, 2009). "Becoming a historian" did not involve working with a historian and, in this case, left little room for inquiry to solve a modern-day problem. Moreover, while Rasori (2009) scheduled the poster board presentation to the entire school to include an audience, the audience is not authentic, nor does the audience have the potential to effect change. Johnston (2008) crafted a similar "becoming a historian" approach albeit one in which students worked outside of the school day.

Students engaged as "engineers" to develop a lunchbox that keeps food cool in what researchers Kim and Deoksoon (2021) called invention-based learning (IBL) that they categorized as a subset of PBL. Specifically, the duo noted student participation in IBL hands-on activities gave them the "opportunities to learn ways of thinking like inventors" (Kim & Deoksoon, 2021, para. 4). However, the "chill-out" curriculum implemented in this IBL experience and developed by Lemelson-MIT required students to learn about heat transfer ideas and participate in science labs before being introduced to the project procedure (Kim & Deoksoon, 2021). This procedure of implementing the chill-out curriculum is contrary to the implementation process of PBL. Additionally,

teachers provided students with materials to make the lunchbox, such as shoe boxes, aluminum foil, packing peanuts, wax paper, and more, thus decreasing the amount of inquiry included in the project process (Kim & Deoksoon, 2021). Neither inventor nor engineer SMEs were a part of the chill-out project.

Much like the lunchbox project, students in a case study from Bolshakova (2019) were told to engineer a mini-greenhouse prototype for their controlled environment agriculture system. This STEM challenge on how to feed three billion people started with a potential for a high level of inquiry until the students were told what to build (Bolshakova, 2019). However, one interviewed student commented, "I was telling my idea, and people were listening, commenting, [and] sharing. You knew that something was going to happen with our ideas" (Bolshakova, 2019, p. 2). Therefore, while the students were not allowed to devise their solution on how to feed three billion people, and no SME was brought into the project process, they were afforded the environment to explore the collaborative prototyping process through trial and error.

Students acted as geographic information systems (GIS) analysts in a gifted-only classroom to develop a community mapping atlas (Shaunessy & Page, 2006). For this project, students identified what they felt were essential points in the community to map as they prepared narratives about the places (Shaunessy & Page, 2006). While GIS was found to "allow students to see the connectivity of the information layers, how each layer relates to another, and how the data may change over time," the mapping project did little more than collect information in a different format (Shaunessy & Page, 2006, p.47- 48). Students did not work with GIS SMEs on the project, even though a GIS analyst was brought in as a guest speaker only in the hopes of encouraging student curiosity in GIS as

a profession (Shaunessy & Page, 2006). This project had the potential to use GIS to spark deeper inquiry to fuel economic development in the community but stopped with the lower-level Bloom's reporting of information, calling into question the findings of connectivity of information layers.

Westberg and Leppien (2018) advocated for bringing in guest speakers to spark the learners' interest in their study in the hopes that the students would want to delve deeper into a topic such as biometric scanning software or unique applications of photography. In no instance did the SMEs function beyond a guest speaker role, and student interest was not guaranteed in this study, nor was inquiry (Westberg & Leppien, 2018). In this study, the target population was again gifted students, which may have impacted the requirement to start with student interest in a career rather than a direct connection to a curricular context (Westberg & Leppien, 2018).

Digital storytelling was the focus of several PBL studies. In an ethnographic study, Castaneda (2013) used digital storytelling to help ELLs communicate emotion to their audience. In a pre/post-test, open-ended questionnaire, Castaneda (2013) found digital storytelling to be an effective tool for enhancing authenticity. "When language is practiced in meaningful context with activities that make connections to learners, students attain competency for real-world communication" (Castaneda, 2013, p.45). Similarly, Yang and Wu (2012) found that digital storytelling students performed significantly better than lecture-type participants in their English proficiency in their quasi-experimental design study. Yang and Wu (2012) indicated the scenario situations presented to students were authentic. However, in both digital storytelling studies, the level of inquiry was limited to the given situation rather than immersing learners in a real

situation that would have required deeper inquiry. Instead of using digital storytelling as the summative product for these projects, they could have been used to scaffold for a higher-level Bloom's challenge in which learners worked with SMEs.

No SMEs: Scenario-Based Projects and Simulations

A fake letter from the mayor was given to Pre-K students in an urban school in Massachusetts asking for a redesign of a local park (Wargo & Alvarado, 2020). Teachers worked with university professors to design the challenge, "How do we build community spaces that are welcoming to, representative of, and sustaining for all community members?" (Wargo & Alvarado, 2020, p. 28). The wording of the challenge questions the understandability of the context for P-K learners and could be a result of working with university professors rather than subject matter experts. A far more straightforward question might have been, "How can we improve the park to make it more fun for all kids?" Additionally, while some inquiry was required to redesign the local park, the teacher determined the local park was where the learners would focus their attention to make it more welcoming, decreasing the inquiry needed to complete the project (Wargo & Alvarado, 2020). No SMEs, such as urban planners or the mayor, were brought into the learning experience, nor were the students' plans brought to the mayor as indicated by the initial letter. Instead, research was limited to student surveys of parents about what should be in the park, a class vote on proposed ideas, and then a created 3-D map of their ideas (Wargo & Alvarado, 2020).

Coppell New Tech High School in Texas is part of the network of PBL New Tech schools that consider themselves to be fully PBL programs in all content areas (Gratch, 2012). In her dissertation research, Gratch (2012) explored three PBL experiences that

were defined as “experiential, often collaborative, learning activities with authentic application and a well-defined question to guide student activity” (p. 7). Two of the three offered examples are included in theme two as the inquiry was limited in each project, and one example (a roast of Teddy Roosevelt) fell into category one. Writing resumes in Spanish and practicing reading those resumes to native Spanish speakers offered a potential real-world context even if the resumes were not used to apply for a job (Gratch, 2012). It is important to note that students had to use their working knowledge of vocabulary and grammar, but the project was lesson-based rather than a sustained duration of inquiry around a challenge. Similarly, student-created documentaries about a local organization were merely shown to parents, few of which showed up for the exhibition night (Gracth, 2012). These documentaries were for information purposes only and did nothing to try and solve the issues that the local organization supported (Gratch, 2012).

While Gratch (2012) focused on teacher perceptions of PBL, it would have been interesting to compare student perceptions of these same projects. Though Gratch (2012) noted teacher perceptions on the effectiveness of PBL were high, student beliefs may have differed. As evidence of the possible difference in teacher and learner insights, Gallup’s (2019) recent survey found that teachers were twice as likely to believe their classrooms were designed around authentic problems as students who believed the same statement. This conclusion is supported by the comments made by a teacher, “on workdays, it is more of a traditional environment because background information might include a teacher lecture or demonstration of the content, all intended for the students’ benefit. The last stage of the PBL involves student research, problem-solving, and

investigation to produce and present a final project, whatever that might be" (Gratch, 2013, p. 60).

Doppelt and Barak (2002) conducted a mixed-methods study to investigate the use of Legos in a PBL classroom to improve students' self-esteem and confidence. In this case, learners acted as mechanics as they built Lego inventions such as a conveyor belt to load a truck and a chocolate drink machine that would mix powder and milk (Doppelt & Barak, 2002). These activities focused solely on building with Legos and using imagination and did not include the inquiry behind the design or why someone might need the invention.

Robotic programming that required the use of students' imaginations was the focus of the Blanchard et al. (2010) case study. Two groups of elementary students were observed and interviewed to determine the situational awareness of the learners (Blanchard et al., 2010). Students were asked to explain their thought process during the programming as they guided a robot to check out a mysterious box that was potentially harmful to humans (Blanchard et al., 2010). Blanchard et al. (2010), despite the scenario situation with little inquiry, found that the immediate feedback provided by the robots on whether or not something happened correctly supported the learners' understanding of the programming process.

Like Blanchard et al. (2010), who used a fake scenario based on danger, Crawford (1998) also presented a fictionalized situation in which eighth-grade science students had to determine, "are there poisons in our lives?" (p. 19). Students had to safely design a way to investigate a chosen poison with their outcomes presented to the class (Crawford, 1998). The question presented to the students was a closed, yes or no answer question

(Crawford, 1998). Furthermore, beyond the safe design of the investigation, students did not go beyond the analysis level of exploration. In contrast, students could have developed a way to expose people to fewer poisons as a more authentic and higher-level Bloom's PBL experience.

According to Clemmons & Sheehy's (2011) case study on developing environmental consciousness, students were authentically engaged in designing a solution to a real-life science problem. Once their research concluded, students simply presented their findings to a fictional grant-funding group (Clemmons & Sheehy, 2011). After a cursory review of this example, had students instead presented their findings to a group of SMEs who could have potentially created change, it would have been categorized in theme three. However, after a closer investigation of the topics explored, little inquiry was required for completion, and the authenticity of the challenges was suspect. For instance, determining how to transport an animal to a different environment than the one in which they live was less than relevant to the students and would require research only rather than exploring a real-world issue (Clemmons & Sheehy, 2011).

Six kindergarten and first-grade students were asked to design an outdoor play space using indoor items in the case study by Essa et al. (2012). These students were chosen to participate based on expressed interest rather than as a whole-class assigned experience (Essa et al., 2012). The play space, while presented to their peers, did not come to fruition as it was a simulated challenge that did not draw on investigatory practices to inquire as to what the peers wanted or what was required to make the outdoor play space a reality (Essa et al., 2012).

Miller (2013) saw a difference between having a purpose for learning versus asking ELLs to regurgitate information in a meta-synthesis study that analyzed digital videos of students telling the story of their immigration. Miller (2013) also noted success in having the ELL students participate in a fictionalized campaign regarding improvements in immigration processes. However, there was no ask for learners to delve deeper into the inquiry process and work with SMEs to determine how to change the immigration process for the better, nor was there any comparison between immigrant stories to determine patterns within the system.

High school earth science students were given scenarios to solve in more of a problem-based format than a PBL approach but were afforded the opportunity to help formulate research questions and data analysis strategies (O'Neill & Polman, 2004). The study revealed that students produced a better analysis of strategies once they were asked to transfer their knowledge. Concerningly, while O'Neill and Polman (2004) did not define authenticity in their study, the pair noted that "brief, well-scripted labs are usually considered the apex of the authenticity for the general student" (p.261-262). Again, no definition of the "general student" was provided, but it leaves one to ponder if O'Neill and Polman (2004) believe authentic PBL should be reserved for higher-level students.

In a master's thesis research study, Blanken (1999) found student engagement increased in social studies classes when fourth-grade learners were given situations "closely related to real-world situations" (p.29). However, the scenario-based case in which students were "hired" by a game company to create a game required very little research into how to make a game (Blanken, 1999). Instead, low-level Bloom's information was used to create game cards (Blanken, 1999).

In a longitudinal study using a design-based implementation research approach, Adams et al. (2017) explored the Knowledge in Action (KIA) PBL-designed curriculum. This curriculum was aimed at an Advanced Placement U.S. government course, which, by nature, is an authentic context for design (Adams et al., 2017). However, the study investigated five units that focused on simulated experiences rather than problem-solving community issues. For instance, students participated in a moot court project and mock legislative sessions rather than writing and sending an amicus brief or writing their own legislation for submission to their congressional representative (Adams et al., 2017). Furthermore, no SMEs were consulted during the simulated experiences.

Lo (2015) used the same KIA curriculum for the AP U.S. government course but centered her research around the voting habits of student participants. Lo (2015) found that students involved in the KIA curriculum produced data that suggested both the "simulation frequency and the situational interest directly predicted students' commitments to vote in the future" (p. 250). Interestingly, Lo (2015) noted, "the key for Social Studies educators and researchers might be to investigate what types of classroom practices, besides simulations, can both trigger and help maintain students' interest in political action" (p. 252). Conclusively, higher-level Bloom's authentic PBL experiences might be those other types of classroom practices noted by Lo (2015).

No SME: Service Learning

Service learning was the focus of Furco (2010) as authentic connections were made by giving back to the community. However, no requirement to move beyond lower Bloom's levels was presented in Furco's (2010) research, as donating food to a shelter was considered an authentic project. Student-initiated projects to complete a portfolio

graduation requirement were coupled with a service-learning element in Bickle's (1994) assessment of the Kentucky Education Reform Act. Here, findings showed students were able to improve their ability to solve problems across content areas for later life connections (Bickle, 1994). However, the inquiry was limited with this service-learning approach to PBL.

The Youth Participatory Action Research program had learners connect with community members to improve their Spanish-speaking skills (Bocci, 2016). From these conversations, students created vocabulary lists to enhance their range of conversational skills (Bocci, 2016). However, no real problems were tackled in this project, although Spanish-speaking adults did work with students to help the youth make connections within their community.

No SME: Research Paper in Disguise

A social justice lens that allowed students to choose their project topics was the focus of McHugh's (2015) dissertation in a fifth-grade math classroom. Issues for exploration included determining why some countries spend more money on education for boys than for girls, why inner-city schools do not have comparable materials to suburban schools, and why gangs have a high percentage of Hispanic members (McHugh, 2015). McHugh (2015) helped students determine how to showcase their findings, including brochures and websites. While the data collected was shared, and in one instance, a child did write a letter to the local paper's editor, the students did not attempt to create a solution to the problems they investigated (McHugh, 2015). Spires et al. (2012) took a similar path to McHugh (2015) in which students created five-minute videos to explore questions related to challenges youth face today and the impact that

global warming has on the planet. However, much like McHugh (2015), Spires et al. (2012) only required lower-level Bloom's cognition.

Tuncay and Ekizoglu (2010) explored what they called "free" PBL, in which students were allowed to choose their topics of investigation. In a descriptive statistics study, two groups of students took exams to determine their understanding of the studied topics (Tuncay & Ekizoglu, 2010). The experimental group was found to have greater achievement when engaged in free PBL (Tuncay & Ekizoglu, 2010). Students designed websites to show their understanding of their chosen topics and then shared the websites with their peers and family (Tuncay & Ekizoglu, 2010). The websites included basic information related to the studied topics (Tuncay & Ekizoglu, 2010).

While not described as "free" PBL, Peters et al. (2019) explored how to capitalize on student interests by allowing them to research a topic of choice. Students were encouraged to collect and analyze data in their sixth-grade statistics unit (Peters et al., 2019). However, students merely wrote a paper displaying the data collected rather than solving the problem investigated (Peters et al., 2019).

Documentary films were the focus of the case study by Dockter et al. (2010), in which students shared their videos with a group of parents to celebrate their social studies/English language arts class culminating projects. However, the contents of the videos left little room for inquiry. While students could investigate topics of their choice, such as the meaning behind Native American pow wows, students presented researched information only rather than analyzing and evaluating that information (Dockter et al., 2010). While students created the documentaries, the creation level of Bloom's was not reached with the information included. However, it is essential to consider that students'

overall thoughts on the project included it was one of the most challenging tasks assigned (Dockter et al., 2010). Additionally, other than stating that PBL "allows students to build their own understanding," no further definition of PBL was provided by Docketer et al. (2010, p. 419).

Ferretti et al. (2001) found that elementary students made gains in their understanding of westward expansion and made improvements in their self-efficacy as learners. In a quantitative analysis of a student project that determined whether or not immigrants should have gone west, Ferretti et al. (2001) noted students should be challenged to solve "ambiguous and vague goals" (p. 63). However, students merely presented written essays on the topic to their parents, which only reached the level of analysis (Ferretti et al., 2001).

In an earlier study by Ferretti and Okolo (1996), the duo found that students' critical thinking skills were enhanced when collaborating on authentic challenges. Students from one class presented their findings on the advantages of industrialization, and students from the other class presented their findings on the disadvantages of industrialization (Ferretti & Okolo, 1996). While an analysis and evaluation took place regarding the industrialization topic, and students created multimedia products to share their results, no creation-level Bloom's cognition was required (Ferretti & Okolo, 1996).

Using a similar level of required cognition, students spent two days investigating what type of alternative energy is best in the quasi-experimental design by Hsu et al. (2014). Students in the experimental group used Webspiration to share their findings, while students in the control group did not (Hsu et al., 2014). After the research phase, learners created an argumentative essay on which type of alternative energy was best,

with the experimental group producing better results (Hsu et al., 2014). Hsu et al. (2014) defined PBL as collaborative and meaningful to students as they work in the manner that professionals do. However, Hsu et al. (2014) could not explain how the argumentative essays mirrored real-world work.

Robertson and Pedesky (2020) conducted a case study in which fifth-grade students analyzed open-ended questions that mattered to them. However, the students did not do anything with their answers to questions such as why dog breeding has negative consequences, what medicine is the most effective in treating certain diseases, and the impact of global warming (Robertson & Pedesky, 2020). The teacher did very little scaffolding as students engaged in analysis and evaluation as they were expected to read extensively to find evidence to support their findings (Roberston & Pedesky, 2020).

Art was the focus of several projects reviewed by Roberts and Trainor (2004). The method used by Roberts and Trainor, the Paideia coaching model of project implementation, is “a unit of study that leads to a student production or performance that demonstrates mastery of a subject to an audience outside the classroom. It is designed to provide students with a strong, experiential connection to the curriculum, thereby making the curriculum more interesting and relevant. Ideally, the coached project provides both teachers and students the opportunity to produce rigorous, relevant work and to measure the quality of that work against authentic standards" (p. 514). In the explored projects, students made a living curriculum of artwork for the school hallways and illustrated scenes from novels read that were displayed in showcases outside of the library (Roberts & Trainor, 2004). Although these projects required design work by the students and took an extended amount of time, with the mural project lasting eight months, the level of

inquiry was limited (Roberts & Trainor, 2004). Roberts and Trainor (2004) did find an increase in student motivation and quality of work since the students knew the work would be placed on display.

Older students teaching younger students was another approach used in theme two projects. Ge et al. (2006) conducted a technology-rich ethnographic study to observe a high school computer class in what was described as a "transition that took place in classroom culture from one characterized by a well-defined problem-solving approach to one more indicative of an open learning environment" (p. 321). Student-generated question and answer games were presented to elementary students in a multi-user environment program that required a Bloom's level of creation for the game but included lower-level Bloom's information (Ge et al., 2006).

At first glance, the student-created infographics on scientific concepts in the Gebre and Polman (2020) study would have been categorized in theme one with the low-level Bloom's focus and activity-like experience. However, the introduction of a science news editor for the American Chemical Society as an external reviewer for the students' work increased the project's authenticity and added some inquiry into the process (Gebre & Polman, 2020). Although the researchers found an increase in student engagement and understanding of the scientific concepts included in the infographics, the inquiry was primarily limited to how they could effectively communicate their ideas rather than focused on solving a scientific dilemma (Gebre & Polman, 2020). This example was the only instance of a research paper in disguise that utilized an SME.

Data Collection with SMEs

Data collection was a popular approach to the studies in themes two and three. However, unlike theme three's studies discussed in the next section, theme two's studies explored lower-level Bloom's questions. Novak and Krajick (2019) explored questions related to the health of the local stream and how people's actions on land potentially impact the stream. Meanwhile, Avraamidou's 2013 case study improved all but one of his students' views of scientists as the learners worked to collect data on the health of their local stream alongside a group of meteorology scientists. While the inclusion of the SME for the data collection would, at first glance, seem to place the Avraamidou (2013) study in theme three, like Novak and Krajick (2019), the learners' inquiry stopped with data collection rather than to solve the problem of improving the health of the local streams in question. Similarly, the Moje et al. (2001) qualitative study that relied on student interviews for data collection followed a seventh-grade bilingual science class as they investigated the quality of their river water. Again, however, outside of the water testing, no effort was made to improve the health of the water.

The Boreal Forest Watch program, developed in the late 1990s in Canada, had the makings of an authentic project-based learning experience as it was developed with scientists who would use the data collected by students (Spencer et al., 1998). However, the carefully planned and executed learning event that fit into "rigid curriculum standards" was categorized into theme two (Spencer et al., 1998). The event failed to have the students do anything with the collected data other than submit it to the scientists (Spencer et al., 1998, p. 32). Moreover, detailed procedures on conducting the data collection were provided to the teachers and students, leaving little to no room for inquiry

(Spencer et al., 1998). This 400 plus page teacher manual included research protocols and accompanying scripts to the provided picture slides (Spencer et al., 1998). While the data needed to be uniform for collection procedures, this admittedly “activity-based program” did not include an open-ended challenge for the students to solve (Spencer et al., p. 39).

Students partnered with marine biologists to learn more about sharks through a data collection process (Seraphin, 2010). While the students participated in designing experimental protocols, in addition to the data collection, the students did not have the opportunity to solve any high-level Bloom’s investigations (Seraphin, 2010). Student surveys taken after the partnership suggested that negative attitudes about sharks were improved, and the student attitudes toward scientists, which were somewhat positive before the partnership began, did improve as well (Seraphin, 2010). However, results showed a lack of student understanding of scientific principles related to the work of scientists, which may have been improved if the partnership extended beyond data collection (Seraphin, 2010). “The students’ unremitting association of scientists with specialized equipment and the students’ lack of personal connection to scientific ways of examining the world, suggest[ed] that partnerships may be more effective at personally connecting students with scientific processes if they explicitly incorporate activities designed to improve students’ view of themselves as scientists" (Seraphin, 2010, p. 203).

Mote et al. (2013) analyzed data to mimic the role of a scientist, and students’ participation in the videoconference “Climate Detectives” allowed them to listen to a scientist explain the data. Like Mote et al. (2013), Xie et al. (2014) conducted pre- and post-test analyses and conducted an end of the project survey to determine how the data collected by students for the NASA Climate Change and Remote Sensing project

impacted the effectiveness of scientific inquiry. However, the data was collected and sent to NASA rather than having the students work with the data to create solutions to climate change (Xie et al., 2014).

Nugent (2019), in the Citizen Science project, followed a parallel path to the Climate Detectives, in which students collected data on bird sightings to share with conservation management teams. Although this Citizen Science project noted a possible extension for students to engage in the restoration of local habitats, there was no requirement for participation and no detailed description of results of any classes that participated in the more fully authentic extension to the project (Nugent, 2019). Klutsch et al. (2020) investigated a similar approach to the Citizen Science project and indicated that any student could become a citizen scientist as they promote environmental stewardship. Through data collection via a newly developed mobile app, students could contribute to potential future research avenues by providing the collected data (Klutsch et al., 2020). However, there were no investigations beyond the data collection.

The Spire et al. (2016) study took a similar path as Moje et al. (2001), Avraamidou (2013), and Novak and Krajick (2019) as students created a public service announcement regarding the local water quality. Notably, the students did include brief recommendations such as contacting a local legislator, which, if developed further, would have moved this PBL experience into theme three (Spire et al., 2016). The study of the EPA-funded Earth 2000 project by Vellom et al. (2000) paralleled the data collection of the aforementioned studies in this section that collected data. This watershed project went a bit further by modeling the data to "produce results closely aligned with experts in the field (Vellom et al., 2000, p. 426). However, the data modeling was not used to solve a

problem within the watershed, and the inquiry stopped, categorizing this PBL experience in theme two instead of theme three.

Concluding Thoughts on Theme Two

While the studies that fell under this theme of academic projects with limited inquiry, Gordon (1998) reminded us that these could be a starting point for later moving into authentic learning contexts. These academic projects take curricular contexts and turn them into structured problems (Gordan, 1998). Gordon (1998) advocated for creating a scenario challenge that would place students in a fictionalized context from which they could later tackle a real-life situation in their community. These real-life situations are what were found in theme three: authentic project-based learning experiences.

Theme Three: Authentic Project-Based Learning Experiences

Kilpatrick (1918) called on educators to think about his Project Method of teaching in a more explicit sense than typical projects experienced in the classroom. To visualize the Project Method, Kilpatrick (1918) asked teachers to consider projects as "pro-jects" in which something is "pro-jected" (p.321). Here, we can align the highest level of Bloom's, creation, with that which is projected. More so, we begin to understand more clearly the definition of an authentic project-based learning experience that creates an opportunity for open-ended inquiry.

When placed in an authentic or real-world context, "students move from passive organizers of detached data to active investigators of contemporary issues within their community" (Donahue et al., 1998, p.18). Newmann and Wehlage (1993) developed conditions for authentic learning activities, including higher-order thinking, depth of knowledge, connectedness to the world outside of the classroom, substantive

conversations, and support for student learning. This detailed definition was frequently absent from the studies included in this systematic review. In many instances, the word "authentic" was included as a reference without any further discussion (Bittel & Hernandez, 2006; Bitz & Emejulu, 2015; Clemmons & Sheehy, 2011; Essa et al., 2012; Green, 1996; Hamzeh, 2018; Harris et al., 2015; Hellebrandt, 1999; Hsu et al., 2014; Johnson et al., 2019; Kemker, 2007; LeBlanc et al., 2015; O'Neill & Polman, 2004; Palatnik & Koichu, 2017; Peters et al., 2019; Price et al., 2019; Rowe & Probst, 1995; Savinovich, 2018; Seraphin, 2010; Smith & Pastor, 2016; Spires et al., 2016; Swingle, 2019; Togia et al., 2014; Vellom & Pope, 2000; Vincente et al., 2021). In placing the reviewed studies into this theme of authentic project-based learning experiences, the Honebein et al. (1993) definition of cognitive challenges that experts would face in the real world outside of the classroom was used. Many of the studies reviewed were more explicit in how the experience was an authentic one and tapped into the most detailed definition of authenticity from Reeves et al. (2002) that included the following components: real-world relevance, and ill-defined problem structure, complex tasks sustained over a period of time, multiple perspectives, collaborative interactions, reflection on choices made, integrated content areas, assessment throughout the activity, authentic products, and diverse possible outcomes.

A quarter of the studies categorized into theme three included the use of subject-matter experts on at least one level. As defined by Ludwig and Owen-Berger (2018), an SME is an individual who works in a particular field of study outside of the classroom, which "focuses on the real-life application of information and helps learners think about content from an enterprise-wide perspective" (p.4). The interaction between SMEs,

teachers, and students differed from study to study. In the most complex experiences, SMEs were involved from planning the learning experience with the teachers and, in some cases the learners, to the execution of the learning process, and finally, acted as an audience after the learning experience.

SMEs Supporting Teacher-Designed Projects

In some instances, teachers find it helpful to go through a complete project's inquiry process before implementing it with their students. Andersen (2011) investigated if, by having teachers participate in the project before students, teachers could use that opportunity to have students co-create the learning experience. To target local issues and determine which SMEs could be brought into a PBL experience, teachers went through a community mapping program to identify how their curriculum connected to their community (Andersen, 2011). It is important to note that Andersen (2011) cautioned teachers to realize that some enthusiastic SMEs could cause a PBL experience to grow beyond the scope of the curriculum and time commitment available. Therefore, it is crucial for both the teacher and SME to "identify what each will do in the partnership" (Andersen, 2011, p.7).

Baumgartner and Zabin (2008) highlighted the importance of teachers working with an SME to design PBL experiences to ensure projects are authentic and have opportunities for SME feedback woven within the experience. The two-year descriptive case study of a 9th-grade science class investigated students working with a marine biologist working toward her Ph.D. as they assisted in gathering data for a dissertation project (Baumgartner & Zabin, 2008). The creation of posters and a field guide to share with 9th-grade peers was a disappointing lower-level Bloom's product that would have

been categorized in theme two (Baumgartner & Zabin, 2008). However, the extension of the authentic PBL experience formed the basis for Honolulu's Nature Conservancy's ecoregional plan for conservation and tidal habitats brought this example into theme three's requirements (Baumgartner & Zabin, 2008).

The interpretive case study by Falloon and Trewern (2013) sought to "explore the experiences of scientists involved in the partnerships and uncovered difficulties in bridging the void that existed between the outcomes-driven, commercially-focused world of research scientists, and the more process-oriented, tightly structured, and conservative world of teachers and schools" (p. 11). The findings across 200 science students and teachers in New Zealand revealed "teachers had a tendency to superimpose on the partnership Notably Falloon and Trewern (2013) acknowledged "scientists need to be more prepared to think and act like teachers than teachers to think and act like scientists" (p.22).

SME Support for Students

The development of authentic project-based learning experiences in K-12 education isn't a new phenomenon. Donahue et al. (1998) examined a series of case studies in the 1980s and 90s that promoted inquiry-based scientific approaches using the five components of inquiry-based learning identified by Krajcik et al (1994). These components included creating a driving question, designing investigations, collaborating with peers and others, conducting authentic assessment, and using cognitive tools Krajcik et al. (1994). Hammett and Dorsey (2020) provided a roadmap for using data in authentic contexts with scientist partnerships. "Solving real-world problems with data means identifying authentic questions that are meaningful to students and provide a foundation

for deep inquiry" (Hammett & Dorsey, 2020, p. 41). These researchers cautioned teachers to start small before embarking on more complex topics (Hammett & Dorsey, 2020).

In 1989, Global Rivers Environmental Education Network (GREEN) was established in Michigan (Donahue et al., 1998). It spread to 18 countries, in an effort to connect teachers, scientists, researchers, government officials, and community partners to "promote student-based scientific research and the development of innovative tools and partnerships for environmental investigation and education" (Donahue et al., 1998, p.16). The pathway to the establishment of GREEN was a five-year endeavor built out of an authentic project-based learning experience that started in 1984 after Ann Arbor, Michigan, high school students recognized an increase in hepatitis cases in their school (Donahue et al. 1998). In an inquiry-based approach to uncover the source of the hepatitis outbreak, the students discovered windsurfing in the Huron River was a common link between the cases and presented their concerns to a professor at The University of Michigan (Donahue et al., 1998). Then, in a collaborative effort with graduate students and scientists from the university and water-quality experts from the National Sanitation Foundation, the high school students went on to propose a plan to the city and county to take action to address the raw sewage leakage in the natural body of water (Donahue et al., 1998). Unlike many of the authentic PBL experiences revealed in this systematic literature review, these students identified the driving question to tackle when they recognized the increase in hepatitis cases.

Donahue et al. (1998) discussed additional authentic PBL experiences implemented through GREEN, allowing learners to identify the driving question through an inquiry-based approach to teaching and learning. At Freshwater High School in

Sydney, Australia, students were concerned about a bright blue-colored hue to a local creek and lagoon (Donahue et al., 1998). The students monitored the water and worked with local scientists and researchers to collect and analyze data, and worked with more than 250 local businesses to change their environmental practices that adversely affected the local water system (Donahue et al., 1998).

In 1987, the Rogue River Education Project (RREP) was established as a planning organization that worked to bring together educators, university researchers, and subject matter experts on water quality to develop authentic project-based learning experiences for students (Donahue et al., 1998). This collaboration between parties led to over 100 schools participating in collecting needed data to inform decision-making on watershed changes within the larger communities served by the watershed (Donahue et al., 1998). Initially, there was no problem solving on the part of the students even though they were able to work with SMEs and act in the role that scientists work. Here, we see an emergence of theme two initially. However, the program expanded into a theme three direction with their next two projects.

In both the Thorton Creek Project (TCP) and Harpeth River Environmental and Educational Project (HREEP), students worked alongside scientists to gather data about their local watershed and, in the HREEP project, additional data about fish specimens (Donahue et al., 1998). However, contrary to RREP, TCP, and HREEP both involved students in solving local challenges (Donahue et al., 1998). In the case of HREEP, students presented their solutions to Saturn Corporation for best management practices (Donahue et al., 1998). The sum of these preceding case studies by Donahue et al. (1998)

differs significantly from the typical watershed projects that fell in theme two's limited inquiry category discussed in the previous section.

To envision deeper levels of inquiry that were necessary for theme three, Hung and Tan (2004) discussed the need for learners to "dive into the real world" instead of practicing for the real world as contrived problems may not necessarily address "real-world needs, undermining the kinds of mathematical problem-solving dispositions of real mathematicians" (p. 170). At The Minnesota New Country School, high school students are self-directed learners who decide their projects (Aslan et al., 2014). The school experienced a 15% increase in math scores and a 13% increase in reading scores when shifted to an authentic PBL model (Aslan et al., 2014). While there were limited offerings of project examples in this study, the student-run business and apprenticeships with local partners were attributed as having a positive impact on student scores (Aslan et al., 2014).

Bradford (2005) found learner motivation increased when producing authentic work for an SME. Learners used data to give back to their California-based communities with specific needs. Here, the students worked with the local fire and police departments to plot and analyze data to find patterns of illegal activity and fire-prone areas (Bradford, 2005). The learners then taught the departments how to use the mapping tool for the data (Bradford, 2005). Additionally, learners used data to find a lost aqueduct that was then placed on the Santa Barbara Trust for Historic Preservation (Bradford, 2005).

In one theme three, high school study, no SME was explicitly mentioned. However, it can be inferred that an SME was utilized. In the Mack and Westenskow (2014) exploration of the success of Expeditionary Learning Schools, chemistry students

created a fireworks' display for the community. No explicit mention of a pyrotechnic expert was included in the study (Mack & Westenskow, 2014). However, it is hard to imagine one would not have been consulted for this level of potential danger (Mack & Westenskow, 2014).

Deep inquiry and partnerships with SMEs were found in a number of middle school and high school settings. However, elementary programs were also included in this theme and category. The second-grade Project PLACE curriculum had social studies students develop ways to increase the interest of new families looking to move to their community potentially (Revelle et al., 2020). A real estate agent worked with the learners to provide feedback on their brochure creations before they were published for public display at the local real estate offices (Revelle et al., 2020). Similarly, in another Expeditionary Learning School, second-grade students worked with a restaurant owner to craft an activity book for waiting patrons (Levy, 2008). In the same school, a leveled-up version of complexity took place in the sixth-grade (Levy, 2008). Students working with city planners and economic development experts to revitalize their city, Rochester, New York (Levy, 2008). This example differed extensively from the theme two Wargo and Alvarado (2020) park example where students merely created a 3-D map of their ideas.

Kneller and Boyd (2008) included an unlikely SME in their case study of a second-grade classroom looking to improve literacy. A master crocheter was an integral part of the success of the multi-faceted approach to connecting crocheting to real-world experiences (Kneller & Boyd, 2008). The use of crocheting was linked to literacy and writing as students engaged in communications with the public for support on how to gain additional supplies for crocheting, and students solved classroom problems such as

how to clean up the messes left from the crocheting experiences (Kneller & Boyd, 2008). Kneller and Boyd (2008) noted what started as a classroom management tactic and a way to increase student dexterity "evolved from an add-on activity to a central literacy event" (p. 137).

Upon first glance, Rowe and Probst (1995) would seem to fall into theme two as learners collected data during weekly field trips to pick up debris on their island community, as the process started as a service-learning option. However, the third-graders took this weekly event further by trying to convince the local city council to put a ballot measure in for the next election cycle that would ban plastic ring usage on the island (Rowe & Probst, 1995). More importantly, students then worked with local conservancy groups and tourism agencies to help implement their ideas on cleaning up the island and attracting more visitors (Rowe & Probst, 1995).

Parallel to the early elementary examples, upper-level elementary students in Israel, when working with teachers, parents, and SMEs, were able to create solutions to developing an alternative and more environmentally-friendly manufacturing process in their community (Taz & Lazarowitz, 2000). This development happened at a higher level than their peers who were not involved in an authentic PBL classroom (Taz & Lazarowitz, 2000). In fact, one SME involved in the project praised the students' work and recalled, "it's amazing how I listened to the students and cross-examined them. Only at the end did I realize how old they were. I am sure that no other learning approach could lead to such understanding, involvement, and excitement" (Tal & Lazarowitz, 2000, p. 185).

Subject matter experts who provided feedback improved the quality of student work. In a case study that analyzed reflection journals, in-class observations, interviews, and a review of the curriculum, student-choice projects in technology classes saw gains in final product submissions (Hill & Smith, 1998). Feedback from SMEs came in the form of portfolio reviews without any other noted interaction between students and their community partners (Hill & Smith, 1998).

SME Opportunity Not Utilized

Some theme three studies had the opportunity to include an SME but did not. Rubrica (2019), in using a mixed-methods Likert-scale survey and review of teacher journals, found a statistical difference in higher motivation and academic achievement with the PBL group of students than their non-PBL counterparts. Using the PBL Works (2019) definition of PBL, students sought to find a more self-sustaining food source in their urban community (Rubica, 2019). This authentic challenge was relevant to the learners, but no SME was introduced into the project process. At the fifth-grade level, student-run businesses that gave back to the community saw improved gains in economic understanding through pre and post interviews and observations (Whitlock, 2013). Again, SMEs were not utilized in this dissertation study, and no mention provided information on the profitability of the businesses.

In a case study that utilized participatory observation techniques, students created a robotic device to measure pollutant particles in the air within their community (Gkiolmas et al., 2020). These students presented their results to peers, parents, and local community members at a concluding public event (Gkiolmas et al., 2020). While the sample size was small, with only seven students enrolled as members of the

environmental team, post-project students noted they still found physics challenging to master even though they became more interested in experimental physics (Gkiolmas et al., 2020). The introduction of an SME into this project may have increased the students' mastery of physics by providing authentic feedback through the project.

Using semi-structured interviews with administrators, teachers, students, and parents, LeBlanc et al. (2015) discovered the emergence of several themes related to authentic learning. School administrators found students more engaged in the learning process (LeBlanc et al., 2015). Teachers believed authentic learning was essential to incorporate in the classroom while desiring more connections between the school and the community (LeBlanc et al., 2015). From the student perspective, there was an appreciation of having the opportunity to experience authentic learning and a perception that school became more fun when authentic PBL was used (LeBlanc et al., 2015). Additionally, parents were found to appreciate the school's use of technology and authentic PBL through an active connection between the classroom and the community (LeBlanc et al., 2015). With as many opinions provided in support of connecting the school to the community, no overt connections were made with SMEs for the project that had students design inventions and financial packages to bring the innovations to life (Le Blanc et al. 2020). The project merely had students present their information to the class (LeBlanc et al., 2020).

In a case study by Galaviz and Peralta (2019), a fifth-grade interdisciplinary class with a high ELA population went beyond the traditional recycling program efforts at their school. To launch the authentic PBL experience, students visited a landfill and heard first-hand accounts from engineers about the impact of waste in their community

(Galaviz & Peralta, 2019). These engineers would have made the perfect SME to interact with the students beyond the role of a guest speaker. While the initial part of the PBL experience focused on lower-level inquiry and creating a campaign to inform students about the negative impacts that waste had in their school, the project was extended to meet the requirements of theme three (Galaviz & Peralta, 2019). Here, students worked to make the breakfast and lunch programs zero-waste experiences with the entire school as the authentic audience (Galaviz & Peralta, 2019).

SME as a Talking Head Only

Hendry et al. (2016) overwhelmingly found students believed their integrated STEM course to be "one of the most engaging electives of all; it successfully integrates PBL in an extensive manner whilst allowing us to express our knowledge" (p.11). However, the Shark Tank project that allowed students to pitch their invention ideas to the class did not include an audience outside of the class (Hendry et al., 2016). Moreover, while the integrated STEM course brought in a local engineer to talk to the class, neither expert was used as an SME to provide feedback or review the students' projects as focused on more authentic projects (Hendry et al., 2016). These authentic challenges included using mechatronics to support people who struggle with day-to-day tasks because of a physical disability and building a drone to save a human life during a natural disaster. (Hendry et al., 2016).

"How can you plan, design, and develop a mobile application for your high school community?" was the focus for the authentic PBL experience researched through a qualitative phenomenological study conducted by Downs (2013, p. 50). Students presented their solutions to the class without the presence of an SME even though an

expert was brought into the class to speak to the students to allow them to "see the work environment of professionals in the field (Downs, 2013, p. 92). Findings showed "in some data collection phases, students lacked motivation to complete tasks or required teacher interjection into the group construct" (Downs, 2013, p. 99). With a high level of authenticity in the project design and the use of Markham's (2006) definition of PBL that required an adult audience, the lack of the SME as an authentic audience at the end of the project may have impacted the level of student motivation.

SMEs as an Authentic Audience but No SME Involvement During the Project

In the case study conducted by Keiper (1999) that included field notes, an analysis of student documents, videoed lessons, and interviews, fifth-grade students explored geographic information system (GIS) problems. Initially, students were given a contrived situation with a single answer, which, had the activity stopped there, would have placed this study in theme one (Keiper, 1999). However, part two of the PBL experience included a local problem for which students had to use GIS to design a location for a new community park (Keiper, 1999). While no SMEs worked with the students during the project, city officials served as the audience (Keiper, 1999).

Shneiderman (1998) noted that PBL must include "ambitious projects" for which students create a solution to a challenge that will have "meaningful results to someone outside the classroom" (p.26). While students had no SME support for their project that attempted to assist elderly individuals with software programs, students did produce a training manual with recommendations for a director of a retirement facility (Shneiderman, 1998). Students implemented a trial-and-error inquiry process to help them develop a product that was ideal for their client-based project (Shneiderman, 1998).

The analysis of grounded theory data revealed using PBL in an ELL population improved oral communication, helped students overcome fears of public speaking, and elevated student interest in learning about their community (Torres & Rodriguez, 2017). These ninth-grade ELL students advanced their levels of connection with their communities (classroom, school, and neighborhood) through the authentic projects they completed (Torres & Rodriguez, 2017). Through interaction within their neighborhood, an increase in friendliness between the school's neighbors and the students occurred (Torres & Rodriguez, 2017). While the students were involved directly with the neighbors and received feedback regarding the neighborhood issues the students needed to solve, no experts were brought into the project to provide feedback on the feasibility of the solutions (Torres & Rodriguez, 2017).

SMEs as an Authentic Audience and SME Involvement During the Project

Berns and Erickson (2001) made sure to have SMEs present at the start and the end of their case study in their high school business and math interdisciplinary PBL experience. A representative from the Chamber of Commerce launched the project that had students focus on improving the community's economic redevelopment plan, for which members of the Chamber of Commerce also returned as the authentic audience for the summative presentation (Berns & Erickson, 2001). Crawford et al. (1999) completed a three-part process design experiment that included designing a project, teaching the project, and examining what happened in the classroom when middle school science students interacted with SMEs outside the classroom. An "analysis of the data suggeste[d] that tasks early in the project were not authentic and did not thoughtfully engage most of the students" (Crawford et al., 1999, p. 705). However, as the PBL

experience progressed and interaction between students and SMEs became increasingly important, the designs of students' investigations changed, and SMEs became an integral part of their project inquiry and served as part of their authentic audience (Crawford et al., 1999).

In the case study by Conner et al. (2013), authenticity was defined as including a field component in which students worked with a local SME. Students in the geology class participated in several authentic PBL experiences that incorporated experts on the project topics (Conner et al., 2013). Students designed a woodland management plan for an area around their school that was evaluated by a state forester and worked with the state forester throughout the project (Conner et al., 2013). Students also created a native wetland plant nursery and planned to enhance a local wetland from which they collected data for a longitudinal study they developed and partnered with the National Aquarium's Wetland Nursery program (Conner et al., 2013). Finally, in the Fossil Finders Program, students worked with a paleontologist and sent samples collected to enter into the database by the Paleontological Research Institute for multiple research studies (Conner et al., 2013). In fact, students found fieldwork with SMEs to be the most engaging part of the authentic PBL experience (Conner et al., 2013).

Heffez and Bornstein (2016) expanded their approach to authentic PBL to include a place-based component with an "adult-initiated" but "youth consulted and informed" approach to the learning experience (p. 120). This high school group of students identified a community location for improvement through a SWOT (strengths, weaknesses, opportunities, and threats) analysis and crafted a landscape design with infrastructure elements support (Heffez & Bornstein, 2016). Students then worked with

SMEs from a university urban planning department to refine their plans (Heffez & Bornstein, 2016). Critically and in opposition to place-based education qualifications, Heffez and Bornstein (2016) opted for a culminating event in which the students presented findings and opinions to the community rather than to the city's governing body. However, it must be noted that in the original design of the authentic PBL experience, student work was supposed to be included in a report by the urban planners to the governing body of the city, which was disappointing to the students (Heffez & Bornstein, 2016).

A year earlier, McKoy et al. (2015) analyzed the results of a similar case study as Heffez and Bornstein (2016). In this instance, the worldwide Youth-Plan, Learn, Act, Now Program (Y-PLAN) was implemented (McKoy et al., 2015). The authentic challenge students explored involved determining the best transportation system improvements for the city and creating better education and employment opportunities for youth (McKoy et al., 2015). In the Y-PLAN program, "once a question has been posed, Y-PLAN students venture outside the classroom and map the school and neighborhood to gather data necessary to address their project question. In Y-PLAN, students examine community issues through the lens of the built environment: housing, transportation, public space, schools, services, and amenities. Students begin to think critically about their observations, and develop other possible avenues of inquiry" (McKoy et al., 2015, p. 234). As noted by a participant student, "with Y-PLAN, it's different because we're part of what's going on in the city. We had to work on communicating our vision to our client" (McKoy et al., 2015, p. 241).

The five-level teaching concept, the Public Participation Spectrum (PPS), was utilized by Ortiz and Keim (2017) as a structural framework for their study. In stages one and two, inform and consult, SMEs were not considered (Ortiz & Keim, 2017). However, in levels three through five, which include involve, collaborate, and empower, SMEs participated fully (Ortiz & Keim, 2017). Here, the authentic projects were developed in line with the Sustainable Development Goals (SDGs) crafted by the United Nations and encouraged community connections that allowed students to engage in dialogue with the SMEs in which students had to listen to a variety of perspectives (Ortiz & Keim, 2017). Specifically, the city helped to fund the project undertaken by the students to eliminate the wealth gap in their community (Ortiz & Keim, 2017).

Letourneu et al. (2019) used an afterschool program to explore how informal learning environments could boost complex mathematical understanding through real-world observations. Here, families participated with elementary and middle school students to use data to improve a local museum's exhibits (Letourneu et al., 2019). Students could design new exhibits or improve old exhibits to make the museum more attractive and engaging to patrons (Letourneu et al., 2019). Exhibit designers from the museum served as SMEs in this project, and students presented their final ideas to these SMEs and museum patrons at the conclusion of the project (Letourneu, 2019). It is unclear whether or not any of the proposed ideas were actually implemented by the museum staff.

Summary of Results

Over three decades ago, Brown et al. (1989) indicated the quandary with which teachers are faced "is determining what should be made explicit in teaching and what should be left implicit" (p. 42). Brown et al. (1989) went on to explain "a common strategy in trying to overcome difficult pedagogical problems is to make as much as possible explicit. Thus, we have ended up with wholly inappropriate methods of teaching" (p.42). Frequently, teachers maintain the belief that "the best and most valued learning is quickly attained" (Nelson & Harper, 2006, p.10). Teachers have embarked on constructivist approaches to learning, including authentic project-based learning, as long as educators have asked questions (Brooks & Brooks, 1999). However, the understanding of constructivism is varied (Brooks & Brooks, 1999). The reflection of this variety of interpretations is apparent in the three themes that emerged from this systematic literature review. While it is impossible to change how definitions have been applied in the research retroactively, it is possible to make recommendations for the future so that teachers are "prepared with the knowledge, skills, and habits of thinking to mentor their students through authentic investigations" (Windschitl, 2002, p. 112).

CHAPTER V

Discussion, Implications, and Recommendations

Introduction

This chapter concludes step seven of Petticrew and Roberts' (2006) systematic review process that disseminates findings using understandable language that has potential implications for policy changes. Chapter IV's tabulation of the research that included a description of the studies, their populations, methods, and results were appropriate to understand the overarching synthesis and was the first step in determining the accompanying commentary included in this chapter (Petticrew & Roberts, 2006). Bronson and Davis (2012) further expanded on this last step of the systematic review process as potentially having a positive impact on practices within the field of study.

Chapter IV synthesized the three themes that emerged in this systematic literature review to determine the patterns that surfaced. This chapter seeks to break apart the themes and provide direction for future research. Using the definitions of project-based learning by Markham et al. (2003) and authentic learning by Newmann et al. (1996), this chapter discusses the possibilities of moving toward a universal acceptance of authentic project learning experiences in K-12 classrooms. More importantly, conclusions on why PBL must be steeped in deeper levels of critical thinking and inquiry are reviewed as opposed to accepting PBL monikers without scrutiny.

Educators must provide their learners with ample opportunities to become participatory members of society through critically addressing social issues and evaluating existing structures within our communities (Stapp et al., 1996). Students involved in authentic inquiry within their communities are also engaged in constructivism

as they experience learner agency (Marx & Freeman, 1996). As students master developing their constructs and tap into community resources, they become members of a more extensive network of learners, which helps them succeed in authentic project learning experiences of a more complex nature (Marx & Freeman, 1996). Within this network, learners are assisted by subject matter experts who can share their skills, knowledge, and experiences integral to completing the authentic PBL investigations successfully (Marx and Freeman, 1996). However, through the systematic review of the literature, it is apparent that not all teachers understand the application of authentic project-based learning in the K-12 educational system.

Summary of Results

As the research in Chapter II indicated, PBL-focused training organizations such as PBL Works (2019) have attempted to define what they consider high-quality PBL and have offered required elements for application in designed PBL experiences. However, the metrics by which these designed learning experiences met a quality definition of PBL varied from study to study. As shown in Table 5, the percentage of reviewed studies that defined PBL similarly varied. One-third of the studies that referenced PBL as the pedagogical methodology utilized failed to specify a definition of PBL. Moreover, within the themes, the breakdown of definitions further provided evidence of a lack of a coherent understanding by the sum of the research reviewed. Table 6 revealed the absence of a standard definition of authenticity with just under one-fifth of the studies that failed to define the context of that referenced as authentic. In studies such as Bitz and Emejulu (2015), no definition was provided for authenticity or PBL, and the terms were not included in the body of the research. However, both authenticity and PBL were

utilized as keywords for the study (Bitz & Emejulu, 2015). If researchers have varying degrees of understanding of PBL, it is conceivable that those same researchers may not know how to implement authentic PBL effectively.

Togia et al. (2014) indicated a constructivist, inquiry-based approach to developing PBL experiences is required. However, teachers do not believe they have ample time to establish these PBL experiences (Togia et al., 2014). Moreover, the semi-structured interviews used in the qualitative study by Togia et al. (2014) revealed that constructivist approaches to learning have advantages over traditional teaching. However, Togia et al. (2014) also recognized that the majority of the study's teachers did not understand how to teach beyond giving advice and providing specific resources. Furthermore, Togia et al.'s (2014) theme one research project noted finding answers to questions that they synthesize and critically assess qualified as authentic PBL. However, the questions answered were not open-ended challenges but rather had definitive answers.

Often, the driving questions that are supposed to be central to the PBL design process are not well-written. Short et al. (2008) had students explore the following question: "How do geckos stick?" Short et al. (2008) noted the question was an engaging one that did help to increase student understanding of the content studied in their chemistry class. Upon deeper analysis of this driving question, it is answerable with a Google search and leaves out the inquiry needed in PBL. Similarly, the students in the Crawford (1998) study investigated "are there poisons in our lives?" While, "did the benefits of industrialization outweigh the costs?" was the closed-ended question posed in the Ferretti et al. (2001) study. The short answer to both of these driving questions is a simple yes or no.

In self-identifying PBL schools such as High Tech High and the New Tech Network, it comes into question the understanding of genuinely authentic PBL. Both schools invite parents and community members rather than subject matter experts as an authentic audience to exhibition nights (Gratch, 2012; Lattimer & Riordan, 2011). These exhibition nights qualify as the "last stage of PBL… to produce and present a final product, whatever that might be" (Gratch, 2012, p. 60). It seems that Gratch (2012) and Lattimer and Riordan (2011) have a questionable understanding of authentic PBL.

Gratch (2012) did not define authentic and stated PBL is "experiential with often collaborative authentic application and an activity" (p.7). In comparison, Lattimer and Riordan (2011) referenced authentic PBL as "real-world questions or challenges through an extended process of inquiry" (p. 18). However, the understanding by Lattimer and Riordan (2011) of inquiry is concerning. Lattimer and Riordan's (2011) project of building a Gaga (Israeli dodgeball) pit was categorized as theme two. In this instance, students could find online construction directions with a quick Google search negating the need for much inquiry. In Gratch's (2012) project, students educated the community about the local Touch of Life organization after researching the organization and interviewing the founder. Again, students could find much of the information online. Similar to Lattimer and Riordan (2011), students could locate much of the information online and did not delve into the inquiry process.

There was a distinct difference between theme two and theme three's data collection-focused projects. Theme two required data collection without an extension to solve a challenge, and theme three's projects had students gather data that was used to solve a complex issue within their community. The Boreal Forest Watch program,

described in theme two in Chapter IV, prepared teachers to implement a scripted curriculum with step-by-step data collection processes for students to follow in a 400-page manual (Spencer et al., 1998). In contrast, the GREEN program partnered with local scientists once students identified a local watershed issue they wanted to solve (Donahue et al., 1998). In the Boreal Forest example, the students collected data and passed it on to the scientists who resolved the regional issue (Spencer et al., 1998). In a much more authentic and deeply inquiry-based approach, the GREEN program had learners solving their self-identified problem with feedback from the scientists (Donahue et al., 1998). These scientists also served as part of the authentic audience and local government officials who could then implement the change desired by the students (Donahue et al., 1998).

As we consider the differences between teachers' approaches to data collection and the use of the data in the classroom, it is crucial to realize how data is used in the world outside of the school system. Letourneu et al. (2020) discovered the need to shift their thinking from “what data can young children collect and analyze?” to “what problems can young children solve using data?” (p.136). Letourneu et al. (2020) did have the luxury of crafting an authentic learning experience outside of the constraints of the school day and without a set of curriculum standards. However, as evidenced from Donahue et al. (1998), a curriculum outline can be met without sacrificing necessary standards.

Notably, the Y-PLAN project investigated by McKoy et al. (2015) called out “other forms of project-based or service learning that may be simulations or learning experiences without direct and reciprocal impact between students/schools and their

communities" (p.240). These partnerships between communities and schools are what is authentic to PBL. While numerous studies concentrated on the pedagogy's implementation effects on student engagement, the generalizability of engagement as involvement in the learning is suspect (Blanken, 1999; Blitz & Emejulu, 2015; Dockter et al., 2010; Galaviz & Peralta, 2019; Gebre & Polman, 2020; Huizenga et al., 2009; Kemker, 2007; McArthur et al., 2002; Whitlock, 2013; Xie et al., 2014). In the Y-PLAN study, students revealed a desire to extend their participation in the learning into continual community change (McKoy et al., 2015). Students involved in Y-PLAN wanted to know what came next in their authentic PBL journey (McKoy et al., 2015). More impressively, the City of Richmond allocated grant funding for additional y-PLAN projects and made several offers to Y-PLAN students for local internships (McKoy et al., 2015).

As indicated in Chapter II, there is limited research related to authentic project-based learning that utilizes subject-matter experts in support of developing projects, working with students to provide feedback, and serving as audiences for student solutions to real-world challenges. Overall, much of the literature to date has focused on how to use SMEs as guest speakers or mentors who provide networking opportunities for students once they graduate from high school (Alper, 2017; Fisher & Fisher, 2018). As evidenced from this systematic review, SMEs were used in merely 37% of the theme two and theme three studies, of which those themes accounted for 67% of the total studies reviewed.

Lost opportunities to fully realize the potential of SME interaction with classes were evident in this systematic review. In the case study presented by Swingle (2019),

after debating the issue of delisting grizzly bears from the federal endangered species list, the assistant regional director of the local branch of the National Forest Service spoke to the class as the culminating event. A more authentic approach would have been to use the director as an SME as students worked collaboratively to develop a plan to protect the grizzly bears better.

While the research was scant, it is imperative to remember SMEs are often unprepared for working with learners as SMEs are experts in their designated field but are not classroom experts (Ludwig & Owen-Boger, 2018). As evidenced by Andersen's (2011) call for explicit roles in the teacher to SME partnership, teachers and SMEs need to learn to work together effectively. Falloon and Trewern (2013) learned scientists were unprepared to take on the role and responsibilities of a teacher, and the teachers lacked a fundamental understanding of how science is used in the real world. In working with over 200 students for four to six hours a week, scientists discovered teachers tended to treat them as classroom babysitters that allowed the teachers to work on other clerical items during their visits (Falloon & Trewern, 2013). The relationship soured between the scientists and teachers, and the program was eventually discontinued (Falloon & Trewern, 2013). The lack of understanding between teachers and SMEs could be the reasoning behind the underutilization of SMEs in the classroom.

As a default for SME to classroom interaction, schools touted as innovative have spent considerable time and effort on developing networks of SME mentors rather than true SME partners (Fisher and Fisher, 2018). In the recent publication of the longitudinal study done about Big Picture Learning, the close, informal relationships that students build with mentors and through internships have led to high college acceptance rates

(Arnold & Mihut, 2020). These same students have also experienced high rates of college attrition (Arnold & Mihut, 2020). To date, there has been no study exploring the rates of college completion for students involved in authentic PBL experiences that utilize SMEs throughout the project process.

Connection of Results with Existing Literature

The definitions of PBL throughout the decades have varied significantly. In its earliest form, Kilpatrick's (1918) project method called for student purpose through project's implementation, which prepared learners for life, and sought to remove the teacher from the project process when possible. Today's more modern version of PBL has been mostly established by PBL Works' guidance and professional learning series of the high-quality PBL framework (Mergendoller, 2018). Between the earliest and most modern-day forms of PBL in the classroom, the diversity with which the pedagogy is applied creates confusion and results in various learning activities that do not align from one researcher to the next (Jonessen & Hung, 2008).

In this review of 145 authentic PBL studies, 48 studies were categorized as extended project-like activities. Consequently, as cautioned by Petraglia (1998) and Roach et al. (2017), the learning activities in themes one and two did not equate with deeper levels of thinking. From the extended activity of making a pre-programmed robot light up elements on a board in the Vincente et al. (2021) study to teaching modern-day penpals how to make a cultural food dish in Makaramani (2015) study, theme one lacked higher levels of Bloom's beyond application. Additionally, as in simulating the colonial-era bartering system in the Bequette (2014) study, theme one often did not include the

authentic, relevant, and complex challenges connected with the community (Petraglia, 1998).

Although PBL Works' (2019) list of essential elements of high-quality PBL include authenticity, some of the 66 academic projects with limited inquiry in theme two reflected Roach et al.'s (2017) sentiment that "not all forms of PBL are authentic" (p.497). Ravitz et al. (2000), with former ties to PBL Works, reminded PBL enthusiasts that even those teachers who indicated they use PBL regularly do not hold true to the definition's fidelity.

This lack of fidelity to authenticity and inquiry was apparent in theme two's studies. Students became "historians" in Rasori's (2009) personally-created PBL unit but merely studied historical figures and presented their findings via a poster board and essay. While acting as a historian fits the defining qualities of authenticity according to PBL Works (2019), since students were acting in a real-world role, this project falls short via the value beyond school needed, according to Newmann et al. (1996). Specifically, "doing involves interacting with the real world" (Heibert et al., 1996, p. 14). Moreover, the higher-order thinking required of the authenticity framework developed by Newmann and Wehlage (1993) was not present in the historian project example as looking up information and presenting that information is lower-level Bloom's in nature.

While theme three's studies provided several definitions for both PBL and authenticity, these studies adhered to the definitions of the terms used in this systematic review. Deeper levels of inquiry were required in these studies. Additionally, while authentic learning activities aren't necessarily defined as PBL by Reeves et al. (2002), the theme three studies mostly contained the qualities developing authentic learning

experiences advocated for by this trio of researchers. The emergence of real-world relevance, ill-defined problem structure, complex tasks sustained over a period of time, multiple perspectives, collaborative interactions, reflections on choices made, assessment throughout the activity, authentic products, and diverse possible outcomes was apparent throughout the theme three studies (Reeves et al., 2002). The additional component from Reeves et al. (2002) of integrated content areas was less apparent but was revealed in Galaviz and Peralta (2019) in their interdisciplinary fifth-grade project that focused on making their school a zero-waste environment.

Theme three's studies connected to the real world and had an ill-defined problem structure through their design and implementation. The sum of the science studies from Donahue et al. (1998) was one of the best examples reviewed that steeped learners in defining a problem in their community and answering it. The Bradford (2005) studies worked with local departments to identify long-range data in a collaborative interaction to create authentic products that improved their communities. Berns and Erickson (2001) and Crawford et al. (1999) utilized multiple perspectives as the students interacted with SMEs throughout the entire project. Conner et al. (2013) was a perfect example of diverse possible outcomes as learners developed a woodland management plan for their school area and enhanced a local wetland from collected data for a longitudinal study they developed. Throughout the entire process, students conducted fieldwork with SMEs (Conner et al.,2013).

Most importantly, the inquiry that was missing from themes one and two materialized in theme three. As crafted by Blumenfeld et al. (1991), for learners to become skilled at using inquiry, they must be engaged in classroom practices that mirror

situations in which SMEs are involved. Suwa et al. (2020) determined learners must develop the challenge's solutions through a series of iterative tasks to become proficient in the inquiry process. While the capacity at which SMEs were involved in theme three differed, the Bloom's level at which the SMEs were engaged in the projects in theme three was higher than in theme two. Ortiz and Keim (2017) exemplified the various levels at which SMEs were involved in authentic projects through their five-level teaching concept, Public Participation Spectrum (PPS). During the inform and consult stage, SMEs were not utilized (Ortiz & Keim, 2017). However, in stages three through five, SMEs participated fully in the involve, collaborate, and empower process (Ortiz & Keim, 2017).

Connection of Results with Theoretical Framework

As a dynamic interplay between social and pedagogical theories, constructivism asserts that students develop the meaning of new knowledge through active participation in their learning (Adams, 2006; Duffy & Cunningham, 1996). Vygotsky, as a constructivist, connected the limitations of testing students to the fact that these tests only indicated what students had learned up to a certain point and did not take into account their learning that would happen in the future (Shabani et al., 2010). Vygotsky coined this occurrence as the zone of proximal development in which "adult guidance" would support students' problem-solving capabilities (Vygotsky, 1978, p.86). Kilpatrick (1918) drew on the constructivist pioneers to develop his project method that advocated implementing projects that were purposeful and became a part of the lives of the students engaged in them. These three elements provided the pedagogical basis of the theoretical framework for this systematic review, as illustrated in Figure 4.

Figure 4

The Revised Connection Between Theoretical Frameworks

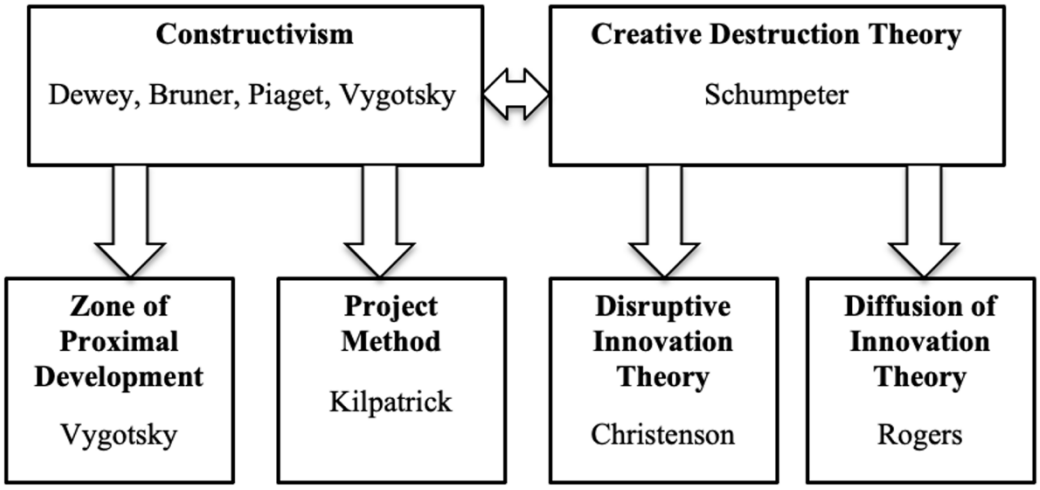


Figure 4 contains the sociological and economic theories upon which this systematic review is defined. The theories have evolved from the inception of the review to the conclusion. The basis for this group of theories is creative destruction, which indicates old systems are destroyed when situations are ripe for innovation (Reier, 2000). With the unexpected COVID-19 crisis of 2020 and 2021, the most significant destruction of education systems in the last century was experienced (Collins, 2020; Sun et al., 2020). The basis for connecting students to SMEs is found in the disruptive innovation theory in which simple solutions disrupt existing markets (Christensen, 2018). Finally, through a detailed analysis of the studies, upon which an additional theory was drawn. The diffusion of innovation theory, developed in the 1960s by Rogers (2003), noted that for an innovation to be widely transferred throughout a system, it must be perceived as new rather than actually be new. After careful analysis of the studies included in this

systematic review, it is evident that true authentic PBL is happening in small pockets, but for those areas in which authentic PBL is not the norm, it will be perceived as a new pedagogical innovation.

Only 7.5% of the studies reviewed used constructivism as a definition for PBL. The levels of constructivism were widely defined and implemented across the three systematic review themes. Through the most basic lens, in theme one, Choo et al. (2009) had students collaboratively complete geometry problems online. While not an authentic PBL example, by definition, this activity did have a high level of constructivism through the collaborative problem-solving process.

The use of the Network for Teaching Entrepreneurship (NFTE) framework and entrepreneurial mindset index developed into a curriculum of role plays, scenarios, and choose the best option activities for New York City after-school programs (Mukhambetova et al., 2019). Three gamified problem-solving scenarios were classified as PBL by NFTE, and while they allowed for a variety of outcomes within the scenario, the scripted curriculum left little room for creation-level Bloom's thinking (Mukhambetova et al., 2019). Even though NFTE referenced BIE's definition of PBL, these scenarios align more closely with Kilpatrick's (1918) description of a set task rather than a PBL experience.

In theme two, students designed games using Scratch programming that requires no background in programming languages, decreasing the level of inquiry and increasing constructivism (Baytak & Land, 2011). Green (1996) provided step-by-step instructions on how to complete each "activity" in determining chemical changes within the water as it interacts with soil. Green (1996) also noted that an extension activity could be extended

to investigate chemical changes "resulting from… human impact on the soil as a consequence of land-use decisions" (p. 36). There was no mention of a further extension of this theme two PBL unit to include determining how to mitigate the negative impacts caused by humans or how to use land reclamation to improve the soil and or water.

Garcia et al. (2020) used the Compose Our World curriculum, which is scripted but allowed teachers to augment or replace an existing project to meet local goals. However, the curriculum permitted little more than a research paper approach through Bloom's, in which students wrote an argumentative essay and designed a museum exhibit of self-created artifacts for parents to view (Garcia et al., 2020). In contrast to themes one and two, theme three's examples of constructivism become a bit more complex to analyze and involve scripted curriculums.

The University of Michigan, in collaboration with Michigan State, developed a four-unit social studies PBL approach for second-grade students in the attempts of determining the effects of PBL in lower socio-economic schools in a cluster-randomized trial that produced two separate published studies (Revelle, 2019; Duke et al., 2020). The economics unit asked learners to create an information flyer about local businesses, which is a lower-level Bloom's activity that would have been categorized in theme one had it not been for an extension to the unit (Revelle, 2019). The more authentic project-based learning experience came to fruition when students created and sold a product for a profit (Revelle, 2019). For the geography unit, students developed a brochure to convince people to move to their area (Revelle, 2019). As these brochures were distributed to the local Chamber of Commerce, an authentic alignment emerged. The deeper levels of inquiry came with the requirement to convince people to move to the area. The history

unit focused on developing postcards to sell at the local library, highlighting historical moments in the town's past (Revelle, 2019). Finally, the most authentically aligned PBL unit that fell into theme three was the government unit in which students proposed new playground improvements to the local government council (Revelle, 2019).

All of these projects for the Revelle (2019) and Duke et al. (2020) studies utilized an authentic audience to which the teachers involved in the studies noted students became more excited about the potential to effect change in their communities. However, the varying levels of inquiry for the PBL experiences showcase the inconsistencies in which project designers apply PBL. More importantly, the projects in question were scripted by university designers, and teachers responded to the percentage range of which they followed the steps listed in a section for the curriculum: fewer than 50%, 50%-80%, and 80% or more (Duke et al., 2020). This admittedly scripted series of projects impacted the level of constructivism from a constructivist purist. Within the Duke et al. (2020) study, the degree to which teachers followed the steps laid out by the curriculum varied, with teachers deciding to skip portions of a lesson or an entire lesson within the PBL unit. The wide range of teacher participants across 11 school districts with a total of 20 elementary schools and 48 teachers may have contributed to the lack of fidelity to the Duke et al. (2020) curriculum's detailed design.

Applying more of a true constructivist approach that aligns with the work of Dewey, Bruner, Piaget, and Vygotsky, authentic PBL experiences will have to move into theme three's categorization and abandon theme's one and two. The scripted curriculums of theme three will also have to leave more room for localized context applications. Therefore, projects like the Boreal Forest program that was developed with scientists,

using Vygotsky's ZPD approach, would have to abandon the more rigid 400-page curriculum guides (Spencer, 1998).

Continuing with Vygotsky's ZPD approach, Seraphin (2010) investigated a grant that provided fellowship support to science graduate students in a partnership with K-12 teachers. This grant was intended to improve the pedagogical practice of the science students so that they could work with teachers in the future, and improve communication and scientific knowledge and skills for the K-12 teachers (Seraphin, 2010). Here, scientists learning pedagogy supports Falloon and Trewan (2010) findings that called out the lack of understanding about the roles of teachers and SMEs in an authentic PBL experience.

Kilpatrick's (2018) project method is the foundation for modern-day PBL, albeit in a significantly revised format (Condliffe et al., 2017). However, Zhao (2012) noted three approaches to PBL are evident: academic, mixed, and entrepreneurial. Zhao (2012) was rejected as the basis for the themes that emerged from this systematic review as theme one did not even qualify as academic PBL. Theme two did align with much of Zhao's (2012) academic and mixed approaches to PBL. Theme three also parallel Zhao's (2012) entrepreneurial approach to PBL.

In Kilpatrick's ideal form of the project method, the removal of the teacher is important (Knoll, 2014). Kilpatrick (1918) did not consider the potential for students to engage with SMEs throughout the project process. Theme three of this systematic review analysis produced results that provided an opportunity for SME involvement or had SME involvement in the authentic PBL experience. Therefore, in a more modern ideal state,

the project method could replace the gradual removal of the teacher with a teacher who facilitates and is supported by an SME.

The creative destruction theory of Schumpeter explored entrepreneurial innovation to create opportunities within a system. (Ulgen, 2013). Through the analysis of the three themes, innovation occurred most frequently in theme three, which is also aligned with Zhao's (2012) entrepreneurial model of PBL. A creative destruction force was at play through projects such as the Global River Environmental Education Network, Thorton Creek Project, and Y-PLAN, (Donahue et al., 1998; McKoy et al., 2015). Projects such as these create learners who add value to their communities as they solve the complex and authentic challenges that are a part of their local world. Therefore, these learners become human capital that aligns with the profit-making necessity that Schumpeter's (1943) disruptive innovations require.

PBL has been a mainstay of more innovative educators for decades. However, a disruptive innovation need not be a "breakthrough improvement" (Christensen et al., 2017). Accordingly, parts of the sustaining innovations of the traditional education system can ultimately be replaced by the authentic PBL of theme three. While there is no requirement for the entire system to be replaced, the utilization of SMEs as guides, facilitators, mentors, and assessors have the potential to transform the learning-to-work classroom environment into a working-to-learn ecosystem of networking support.

The diffusion of the innovation happens through interpersonal networks as peers provide opinions and evaluations even though mass media might spread the idea initially as it unfolds over time (Rogers, 2003). In analyzing the studies included in this systematic review of the literature, it is clear that authentic project-based learning

experiences are not new. In fact, some of the most innovative examples of authentic PBL that used SMEs took place in the 1980s and 1990s (Crawford et al., 1999; Donahue et al., 1998; Hill & Smith, 1995; Rowe & Probst, 1995). Here, Donahue et al. (1998) provided a longitudinal view of STEM PBL studies throughout the 1980s and early 1990s.

Implications for Policy and Practice

Due to the effects of the COVID-19 crisis, in the spring of 2020, policy and practice changes toward a more widely adopted authentic project-based learning experiences pedagogy may have gained some traction. Over the last two decades, PBL has been considered the most promising student-centered methodology to overhaul how educators teach, but a more detailed exploration of truly authentic PBL experiences is long overdue (Schneider, 2018). With the complete shutdown of educational institutions worldwide in the early spring of 2020, COVID-19 forever impacted how we view the landscape of educational reform. Therefore, authentic project-based learning can find itself at the forefront of educational disruption models. Zhao and Watterson (2021) articulated three recommended changes to education in a post-COVID-19 world: a personalized curriculum that evolves based on the learner's needs, student-centered and authentic pedagogy tied to inquiry-based learning, and blended-learning opportunities. The question remains as to what level of professional learning teachers will receive to transform their classrooms into ones that reflect the vision of Zhao and Watterson (2021).

Various student-centered learning strategies have found their way into classrooms since the turn of the twentieth century. Whether Kilpatrik's (1918) project method, or the constructive constructs of Dewey, Bruner, Piaget, and Vygotsky (Adams, 2006), there are over a century of student-centered pedagogical options that have built the foundation for

modern-day authentic PBL. However, many teachers still experience reluctance in fully adopting these practices (Mergendollar & Thomas, 2001). Grossman et al. (2019) determined teachers need professional learning support to develop student-centered classrooms through pedagogies such as PBL. Through the systematic review process, it was evident that teachers engaged in authentic PBL do, in fact, need professional development opportunities.

Here, it is essential to reiterate the ex post facto study conducted by Pablos et al. (2017), in which 93% of teacher respondents indicated teaching through the project helped them gain the pedagogical skills they needed to implement PBL successfully. These findings are contradictory to the same group of teachers, of which a third responded that a lack of support by their district administration hindered their PBL efforts (Pablos et al., 2017). Savinovich (2018) found elementary teachers who participated in significant PBL training versus a quick session were better prepared to implement projects in their classrooms. Engagement in students increased when teachers participated in a training offering by the Central Florida Zoo that allowed the teachers first to create a digital story about their zoo experience that they then modeled for students (Kemker, 2007). While the Kemker (2007) experience was aligned with theme two rather than three, it is beneficial to note that professional development supported the teachers to transfer the pedagogical change within their classrooms.

Few opportunities for professional learning coincided with the PBL studies reviewed. For those studies that referenced professional development offerings, the length of those training sessions varied greatly. The Boreal Forest Watch program provided a three-day training workshop (Spencer et al., 1998). In comparison, the social

studies multi-unit PBL curriculum for second grade, developed by the University of Michigan and Michigan State, lasted a mere three hours with a follow-up 100 minutes of webinar training (Duke et al., 2020).

In studies in which teachers did receive professional development on PBL before implementing the PBL experience in question, results varied. In the aforementioned Duke et al. (2020) study, in which teachers received a three-hour session prior to the start of the PBL curriculum implementation, some teachers had been exposed to PBL previous to the study's training offering. According to Duke et al. (2020), "even among those reporting having received prior PD in PjBL, there was no indication from observations and questionnaires that comparison group teachers actually used a PjBL approach to teach social studies, nor, from interviews, that any but one experimental group teacher did so prior to the study year" (p. 174). These findings from Duke et al. (2020) provide uncertainties in the quality of training garnered from PBL professional development providers and, more so, in the sustainability of the training to create lasting change in pedagogical approaches in the classroom.

Likewise, in the Bequette (2014) study that utilized SMEs to develop initial projects and then provide professional development to teachers, only 25% of the trained teachers continued to use PBL after implementing the SME-designed learning experiences. Teachers, in this case, were not only trained and paid for their training sessions but were also given additional release time to plan their PBL experiences (Bequette, 2014). However, it must be noted that the projects designed by SMEs in this mixed-methods study were categorized as theme one extended-activity experiences.

In a study by Hofer and Lembens (2019), professional development for science teachers in inquiry-based learning, a subset of PBL, was found to improve science teachers' attitudes toward shifting to a more inquiry-based classroom. These findings align with the diffusion of innovation theory in which adopts of innovative ideas must go through five stages within the innovation-decision process (Rogers, 2003). Specifically, Hofer and Lembens' (2019) findings align with step two of the innovation-diffusion process. After gaining basic knowledge about an innovation in step one, adopters must be persuaded by peers before developing a positive attitude toward the innovation (Rogers, 2003). Eventually, these potential adopters will decide in stage three, go through implementation in stage four, and finally enter into the last stage, confirmation (Rogers, 2003).

However, SMEs and teachers may not know how to work together effectively. Falloon and Trewern (2013) were surprised to discover that teachers needed more assistance than the scientist SMEs with which they were partnered. The scientists were "confronted with clear evidence that teachers' understanding of scientific thinking and general science literacy was alarmingly low. They frequently did not possess the knowledge needed to support the open vision of the project, nor to facilitate 'just in time' knowledge development to support student-led inquiries" (Falloon & Trewern, 2013, p.18). Although, from the teachers' perspectives, the collaboration resulted in a "tendency to superimpose on the partnership a stereotype in which the scientists acted simply as experts and suppliers of knowledge, rather than co-participants in a learning process alongside themselves and their students" (Falloon & Trewern, 2013, p. 16).

While Falloon & Trewern (2013) acknowledged the potentially limited generalizability of their case study, lessons can be drawn from their findings.

The success of an SME-teacher relationship is predicated on cooperation and collaboration in setting goals for a project (Posnanski, 2002). The SME and teacher must work together to design the authentic learning experience if widespread adoption of innovative pedagogical approaches such as authentic PBL is to occur. Currently, teachers may expect SMEs to write the projects when the SMEs do not have the pedagogical "resources, knowledge, expertise, or experience" (Falloon & Trewern, 2013, p. 17). From the SME perspective, the goal is to "empower schools to do science properly" or any other content area, while the teacher's job is "to interpret this with our help" (Falloon & Trewern, 2013, p. 17).

During their study of teachers new to PBL implementing a project, Boardman et al. (2017) used university partners as academic SMES that planned for higher-order Bloom's projects and even taught lessons when teachers needed support. However, even with the extra help in designing and teaching activities, Boardman et al. (2017) still found that teachers traditionally spent more time discussing the literary text than implementing and facilitating a PBL approach. As a result, students merely crafted video productions or graphic narratives of what they thought a hero was after reading their novel (Boardman et al., 2017). It is important to note that many of the teachers in this study had not been trained in PBL (Boardman et al., 2017). This study calls into question how the outcome may have differed if true SMEs were utilized. Moreover, a consideration for the reciprocity between SMEs and teachers is paramount (McKoy et al., 2015). In the Boardman et al. (2017) case, there was no reciprocity evident in the SME partnership. In

comparison, McKoy et al. (2015) Y-PLAN project had students working with city planning officials in which "reciprocity was evident through the City's inclusion of Y-PLAN as an official component of community outreach in the South Richmond Transportation Connectivity Plan. For students, the real-world client and research distinguishes Y-PLAN and builds core college readiness skills" (McKoy et al., 2015, p. 241).

Due to a lack of scaffolding through the project process, Bernt et al. (2005) discovered learners "had difficulty articulating the social issues that were the focus of the overall project (p.42). Part of this difficulty may have been in the project's design with students only undertaking lower-level Bloom's, theme two, understanding, application, and analysis of the topic on whether or not media reinforces or hinders diversity in the workforce. However, the researchers also noted that the students "really learned, not just about the media and the survey but also how to solve problems and how to follow through to complete a task" (Bernt et al., 2005, p. 41). It seems as if the understanding of Bernt et al. (2005) on how to implement PBL with the appropriate supports is in question. The lack of understanding supports the conclusion that the design of an authentic project-based learning experience is only half of the required comprehension that teachers must have to successfully implement the pedagogy into their classrooms. Thus, PBL professional learning opportunities must include more than design-focused elements from an overarching approach and incorporate how formative assessment data is gathered and used to inform instruction throughout the project implementation.

As educational practice changes are considered in classrooms across the globe, we must ensure that policy matches the desire to alter pedagogical realities. Therefore, local

districts, state education departments, and the federal government need to provide the time, funding, and resources to ensure successful implementations. However, before these changes can occur, a fundamental shift in the systemic beliefs of what school is and should accomplish must come to fruition. "The unheralded importance of activity and enculturation to learning suggests that much common educational practice is the victim of an inadequate epistemology. A new epistemology might hold the key to a dramatic improvement in learning and a completely new perspective on education" (Brown et al., 1989, p. 42).

Recommendations for Future Research

Future research in an authentic PBL context must clearly define project-based learning and authenticity at the start of a study. This systematic review included 48 studies that did not define PBL and 25 studies that failed to clearly articulate the meaning of authenticity even though the researchers utilized the terminology throughout their articles. The remaining studies varied in their definitions with no standard application of either term. More importantly, all PBL studies, no matter the topic focus, must detail the project implementation as it aligns with the definitions of PBL and authenticity utilized in each study. This requirement of a detailed implementation plan will help ensure that researchers, no matter their level of exposure to PBL, will have the opportunity to appraise the design of PBL experiences critically. A detailed explanation of implementation will ensure fewer instances of PBL categorized inappropriately when, in fact, the pedagogical approach was merely a collaborative activity, problem-based learning, or an end of unit project.

A PBL approach to curriculum cannot be downgraded to a recipe to follow (Brown & Edelson, 2003). Thus, subject matter experts and community partners who invest time and money into creating a curriculum could utilize their talents and knowledge more effectively. Directly working with teachers to design authentic and relevant learning experiences and then supporting students through feedback processes as the learners work to solve the challenges is recommended. Additionally, these SMEs could later serve as the authentic audiences for the student solutions as the SMEs work to bring the students' solutions to fruition. Therefore, research efforts should center around the interactions between SMEs and teachers, and between SMEs and students.

Further evidence is needed on how to integrate an SME into an authentic project process effectively. Research has shown that SMEs have difficulty understanding pedagogical implications in the classroom (Diezmann & Watters, 2015; Falloon & Trewern, 2013). Conversely, compared to trained teachers, SMEs also have a higher level of intricate knowledge in the content area they are asked to tackle (Diezmann & Watters, 2015; Falloon & Trewern, 2013). A research emphasis on if there is a change in teachers' designs of projects from ones that fall into themes one and two to projects that fall into theme three is recommended when working with an SME. Additionally, research on how student work improves when they interact with an SME throughout the project process has the potential to have an immense impact on how students can ultimately build their network, as recommended by Fisher and Fisher (2018).

Additional research should focus on the proffered tips and tools for PBL implementation. A thorough search of nine databases in this systematic literature review returned 747 studies from the initial search results. The 192 studies that focused on tips

and tools for implementing PBL were eliminated as non-germane to the goals of this systematic review. However, a thorough systematic review of the studies in this category would offer a broader look into how PBL is defined and applied in the K-12 setting. More specifically, an exhaustive review of this PBL research category could provide further insight into how authentic PBL is classified. Gambrell (2015) noted students who summarize a novel they've read does not provide an adequate example of an authentic PBL experience. However, Gambrell (2015) claimed that shifting a more traditional summary to an exercise in which students tweeted about the book they read made the necessary advancements to authentic PBL. While tweeting about a book a student has read takes a more targeted approach to effective communication, and does so in a public manner, this example neither falls into the category of project-based learning nor fully encompasses an authentic approach to higher-order thinking.

Authentic assessment is an additional area for future research. As was evidenced in the initial analysis of the studies reviewed in Chapter IV, the assessments in question for each study did not always align with higher-level Bloom's thinking, nor were they all authentic. Except for a limited number of studies, little authentic PBL research explored the improvements that students had on standardized tests (Adams, Lo, Goodell, & Nachtigal, 2017; Cervantes, 2013; Lo, 2015; Turk & Berman, 2018). It is also important to realize these four studies were classified in themes one and two versus theme three. This classification leaves researchers to question the potential effects of a truly authentic PBL approach on student testing outcomes.

While standardized tests are antithetical to authentic PBL, the use of these tests is unlikely to go away in the near future. In support of this claim, the Biden administration

required all state tests to be given during the 2020-21 school year despite the lasting effects of the COVID-19 shutdown of schools (Ujifusa, 2021). Thus, researchers investigating alternative forms of student assessment would be better served to focus on the impact that authentic PBL has on these standardized tests.

Currently, one of the most touted innovative approaches to assessment, The Stanford Center for Assessment, Learning, and Equity (SCALE), has a focus on performance assessment rather than traditional standardized exams (Stanford Center for Assessment, Learning, and Equity, n.d.). SCALE maintains a mission to "improve instruction and learning through the design and development of innovative, educative, state-of-the-art performance assessments and by building the capacity of schools to use these assessments in thoughtful ways, to promote student, teacher, and organizational learning" (Stanford Center for Assessment, Learning, and Equity, n.d., para. 1). However, upon further review of the SCALE-designed PBL curriculums, we find another instance of a lack of standardized definition for PBL and authenticity and projects that fall into themes one and two of this systematic literature review.

The sixth-grade science curriculum that explores how the environment and genetics affect who we are has a culminating group project in which students create a story that teaches the reader about heredity and how characters interact within an environment (Stanford Center for Assessment, Learning, and Equity, nd.). This project falls into theme one as a research paper in disguise that leaves learners in the application level of Bloom's. The individual culminating project for this same unit is a simulation about pigeon genetics that results in students creating a new breed of pigeons (Stanford

Center for Assessment, Learning, and Equity, n.d.). This project example falls into theme two of this systematic literature review with analysis and evaluation.

As another example, a seventh-grade science unit on a balanced biosphere falls into theme one, as students must design a map of a hunger games arena. This extended activity requires students to complete five tasks before beginning on their culminating hunger games area that should look like a biosphere on Earth. Here, there is no teaching through the project, but instead, the project concludes as an application-level of the students' knowledge of the information taught during the previous five tasks. These examples from SCALE are in line with the scripted curriculums reviewed in theme two (Duke et al., 2020; Garcia et al., 2020; Harris et al., 2015; Mukhambetova et al., 2019).

This systematic literature review uncovered multiple areas for recommended future research directions. At the most basic level, research must designate clear definitions of authenticity and PBL. Furthermore, a detailed outline of the project in question is paramount to ensuring proper classification of authentic PBL by the study designers. With the excessive returns of studies that explored a variety of tips and tools for implementing PBL, a more thorough review of the offered options, perhaps at the systematic level, should take place. A focus on the tools and various support on implementing authentic PBL experiences could potentially impact the overall design of these projects. These explorations could lead to a better understanding of how SME design integration with teachers and partners with students improves student outcomes. Finally, just as an assessment contains a summative component for review, future research must explore the impact that authentic assessment has on more traditional assessment approaches used by schools, districts, states, and national governments.

Summary

"Rather than being a shot in the dark, evidence-based education suggests that policy formation should be informed, and policy-decision making should be based on the best information to date rather than on hunch, ideology, or political will" (Cohen et al., 2011, p.336). Following the goals articulated by Grant and Booth (2009), this systematic literature review sought to increase the understanding of how the design and implementation of a project-based learning unit of study are enhanced when it is an authentic experience. Through this systematic literature review, a synthesis of a large body of research related to authentic project-based learning experiences was completed to "bring research closer to decision-making" as a more comprehensive source of information for policymakers, stakeholders, parents, and educators (Thomas & Harden, 2008, p.2). Further, this review helped identify the weaknesses in the existing research and provide direction for future research that Petticrew and Roberts (2006) noted is essential in defining policy and practice for improving a career field.

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Zhao, Y. (2012). *World-class learners: Educating creative and entrepreneurial students.* Thousand Oaks, CA: Corwin.

Zhao, Y., & Watterson, J. (2021). The changes we need: Education post COVID-19. *Journal of Educational Change, 22*, 3-12. https://doi.org/10.1007/s10833-021-09417-3

VITA

Education

Sam Houston State University (2021)
Instructional Systems Design and Technology
Dissertation Topic: A Systematic Review of the Literature: The Impact of Constructivist Learning Through Authentic Project-Based Learning Experiences

Wilkes University (2012)
M.S. 21st Century Teaching and Learning

University of Pittsburgh (1998)
M.Ed. Curriculum and Instruction
Secondary Social Studies

Virginia Polytechnic Institute and State University (1995)
B. A. History
Emphasis: Recent American

Certifications

Pennsylvania Level II Teaching Certification Social Studies (1997)

National Board for Professional Teaching Standards
Adolescent and Young Adult Social Studies (2004, 2012)

Academic Positions

Project ARC, LLC (November 2014 - Present)
Founding Partner, Educational Consultant, Curriculum Developer, Online Course Developer

Wilson College (September 2017 – Present)
Instructor: MAT Technology program

Buck Institute for Education Senior National Faculty (2009-2017)

Laur Educational Consulting (September 2006 – 2017)
Conference Presenter and Independent Consultant

Central York School District, York, PA (September 2000 - January 2012)
Social Studies Teacher and Department Chair, Health Sciences and Human Services Career Academy Coordinator, District Presenter

Baldwin-Whitehall School District, Pittsburgh, PA (September 1998 - June 2000) Social Studies Teacher, National Honor Society Sponsor

Honors

PA Civics Teacher of the Year (2011)

Shippensburg Outstanding Teacher and Guest Lecturer (2011)

Microsoft's Daily Edventures 365 Teacher Hero (2011)

Featured *Edutopia* Teacher
Schools that Work Video Series: Integrated Instruction (2011)

Featured *National Institute of Professional Practice* Teacher (2011)
Authentic-Based Learning Video Series

Professional Memberships

(ASCD) Association for Supervision and Curriculum Development
(ISTE) International Society for Technology Education
(PAECT) Pennsylvania Association for Education Communications and Technology
(TCEA) Texas Computer Education Association

Publications

What was your most powerful personal experience in a learning community? (2011, *The EARCOS Journal: A Link to Educational Excellence in East Asia*)

The eight essential elements of project-based learning (2012, *Tech Edge Journal*)

Laur, D. (2013). *Authentic Learning Experiences: A Real-World Approach to PBL*. New York, NY: Routledge.

Instant Edmodo How-To (2013, Packt Publishing)

PBL 101 Workbook: 3rd Edition (contributing author) (2013, BIE)

Teaching Techniques: PBL – online video series (2015, Lynda.com – now LinkedIn Learning)

Laur, D. & Ackers, J. (2017). *Developing Natural Curiosity through PBL: 5 Strategies for the PreK-3 Classroom*. New York, NY: Routledge.

Authentic Project Based Learning through Digital Portfolios (2017, Freshgrade)

Casey, K. (2018). *Moving toward mastery: Growing, developing and sustaining educators for competency-based education*. Vienna, VA: iNACOL. (Acknowledged Collaborator)

Learners are More than a Score (2019, *The Reformer:* ASCD Pakistan)

Laur, D. (2019). *Authentic Project-Based Learning in Grades 4-8: Standards-Based Strategies and Scaffolding for Success.* New York, NY: Routledge.

Laur, D. (2019). *Authentic Project-Based Learning in Grades 9-12: Standards-Based Strategies and Scaffolding for Success.* New York, NY: Routledge.

International Online Course Author

LinkedIn Learning (2015): *Teaching Techniques: Project-Based Learning*

Canopy Lab (2020): *APLE Bites: The Five Stages of Assessment*

Listenable (2020): *Authentic Project Learning Experiences: How to Level-Up Your Classroom Pedagogy*

Featured Panelist

Experiential and Project-Based Learning (2011, The Education Policy and Leadership Center Arts and Education Initiative)

Can We Speak? A Conversation on Civility and Democracy – Featured panelist with Ken Burns for History (2012, National Constitution Center, C-SPAN coverage)

State and Local Conference Presentations

Classrooms for the Future Lesson Plan Presenter (2009, PETE & C, Hershey, PA)

Collaboration through Technology Immersion (2010, PETE & C, Hershey, PA)
PBL to Promote Technology Integration: Keynote Speaker (2010, Classrooms for the Future Boot Camp, Hershey, PA)

Art Meets Politics: An Award-Winning Interdisciplinary Learning Experience (2011, Seamless and Sustained: An Integrated Curriculum Conference, PA)

Developing Authentic Learning Experiences through Technology Connections (2012, PETE & C, Hershey, PA)

Authentic Learning Experiences: A Real-World Approach to PBL (2014, PBL NY, Albany, NY)

PBL 101 (2013, 2014, 2015, PBL World: Napa, CA)

From Teachers to Leaders: Designing Authenticity at all Levels (2014, TCEA, Austin, TX)

Elevating Your Learning ARC: From Challenging Assignments to Authentic Challenges (2015, Southeast Region Education Board, Atlanta, GA)

Authentic, Relevant, and Complex Challenges in a Technology Environment (2015, High AIMS Summer Institute, Cincinnati, OH)

Authentic Challenges in STEM – Keynote Speaker (2015, Virginia Military Institute STEM Conference, Leesburg, VA)

Supporting Your Authentic Challenges through Formative Assessment (2016, High AIMS Summer Institute, Cincinnati, OH)

Turning Up the H.E.A.T (2016, Downingtown EdTech Conference, Downingtown, PA)

The Power of Place: Featured Ignite Session (2016, Downingtown EdTech Conference, Downingtown, PA)

Optimize Your Afterschool Experiences: Moving to Authentic, Relevant, and Complex Challenges to Empower Learners (2017, Extra Learning Opportunities Conference, Harrisburg, PA)

From Teachers to Leaders: Designing Authenticity at All Levels (2017, TCEA Area 7 Conference, Austin, TX)

PBL to #GROW Your Classroom (2017, GROW#17 by Teach Thought, Louisville, KY)

Critical Thinking to Enhance Authentic Learning (2017, High AIMS Summer Institute, Cincinnati, OH)

From Neuro-hacking to Nanotechnology: The Future of PBL Design (2018, TCEA, Austin, TX)

From Neuro-hacking to Nanotechnology: The Future of PBL Design (2018, PETE & C, Hershey, PA)

PBL to #GROW Your Classroom (2018, GROW#18 by Teach Thought, Louisville, KY)

The Future of PBL Design (2019, SAS Institute, Hershey, PA)

Play Your Hand Right and Increase Your Formative Assessment Game (2020, PETE & C, Pittsburgh, PA)

National and International Conference Presentations

Meeting the Common Core: Rigorous, Relevant, Project-Based Learning Enhanced through Technology (2011, ISTE; Philadelphia, PA)

Technology Use to Support PBL and Meet the Standards of Learning (2012, ISTE; San Diego, CA)

Meeting the Common Core: Rigorous, Relevant, Project-Based Learning Enhanced through Technology (2013, ISTE; San Antonio, TX)

PBL 101 (2013, PBL World Australia; Sydney, New South Whales)

Authentic Learning Experiences: A Real-World Approach to PBL (2014, ASCD; Dallas, TX)

Common Core: Rigorous, Relevant, Technology Enhanced PBL (2014, ISTE; Atlanta, GA)

ARC Learning (2015, Quality Schools International – China; Shenzhen, China)

Common Core Meets PBL via Technology (2015, ISTE; Philadelphia, PA)

PBL to Enhance Student Creativity through Technology (2016, ISTE; Philadelphia, PA)

Meeting the Common Core: Rigorous, Relevant, Project-Based Learning Enhanced through Technology (2016, ISTE; Denver, CO)

Developing Natural Curiosity through PBL (2017, Learning by Design; Brussels, Belgium)

Developing Natural Curiosity through PBL (2017, ISTE; San Antonio, TX)

PBL to Enhance Student Creativity through Technology (2017, ISTE; San Antonio, TX)

PBL to Enhance Student Creativity through Technology (2018, ISTE; Chicago, IL)
*updated version; co-developed with P21's Executive Director, David Ross

Deepening Natural Curiosity: The Future of PBL Design (2019, SITE; Las Vegas, NV)

Developing Deeper, Authentic Learning and Critical Thinking Through Project-Based Learning (2019, Learning and The Brain; Boston, MA)

Level-Up Your Online and Blended Instructional Practice Through the Lens of the SAMR Framework (2020, Knowledge Caravan Virtual Learning Opportunity; Kazakhstan)

Level-Up Your Online and Blended Instructional Practice Through the Lens of the SAMR Framework (2020, EdTech South Australia, Inaugural Online Symposium)

Authentic Project Learning Experiences to Level-Up Student Creativity (2020, LearnLife Virtual Conference; Spain)