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Impacts of Project-based Learning on Secondary Education

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IMPACTS OF PROJECT-BASED LEARNING ON SECONDARY EDUCATION

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Abstract

This literature review examined the impacts that Project-based learning (PBL) can have on secondary education. The research parameters for this study were such that the studies included in the thesis were from research that was published between the years of 2018 and 2023. The studies used in this literature review were from many diverse secondary classrooms throughout the world with varied amounts of both teacher and student participants. The studies cited within this review included research that was qualitative, quantitative and mixed methods. The data collected throughout this review strongly indicates that PBL has a positive impact on teacher practice, as well as student engagement, motivation and creative thinking in many varied disciplines and courses.

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CHAPTER I: INTRODUCTION

Project-based learning (PBL) is an active, inquiry-based, and student-centered method of teaching that continues to rise in popularity (Perry, 2018). However, just like any teaching method the question must be asked, does it actually work? Authors, educators, and researchers alike seem to have to come to conclusions that PBL is a viable teaching method and in some cases can be superior to others. Haatainen and Aksela (2021) claimed that the success of the PBL method in the classroom relies heavily on the instructor's understanding and implementation of this teaching practice. Almulla (2020) discovered that this method can promote authentic learning and questioning for students as they engage with more real-world problems through their PBL courses. Hanham et al. (2020) concluded that there seems to be a positive correlation between collective efficacy and student performance when administering the PBL method.

This thesis has three main goals. The first goal will be to determine the impact project-based learning has on the teacher's role in the classroom. Perry (2018) suggested that PBL should be student-centered which primarily means the students are doing the majority of the work in the classroom; whereas, "The teacher acts to facilitate teamwork and not as a lecturer. In many ways the teacher acts like a coach, encouraging students to think critically and pursue the end goal of the project" (Perry, 2018, para. 8).

The second goal is to ascertain how student success and self-efficacy can be measured within project-based learning. Larmer (2018) claimed that PBL helps build the skills of critical thinking, real-world problem solving, and collaboration that students need to succeed in 21st century education in more effective ways than traditional forms of instruction. However, some research studies have found difficulties with the PBL method regarding assessment of student learning. For example, Perry (2018) noted, "assessing learning with PBL can be difficult due to

the potential for subjectivity and inconsistency when evaluating the outcomes of PBL" (para. 15). Haatainen and Aksela (2021) found that of the 244 teachers that participated in their study, all reported difficulty with assessment of their students as well as challenges in the actual execution of PBL. Although there are valid concerns about the effectiveness of PBL, this is a method of instruction that has many benefits for students and teachers alike, and when it is done well can lead to wonderful educational outcomes for students (Haatainen & Aksela, 2021). The third goal is to determine the ways in which project-based learning is currently utilized to enhance student experience in a subject area. For example, Perry (2018) observed that "PBL is especially popular in STEM instruction, but its application should not be considered to be STEM-centric but rather an approach with applications across curricula" (para. 18). As well, Larmer (2018) found that PBL can be effectively used in a single subject or as an interdisciplinary method where it is taught by a team of teachers in art, English, math and science.

Chapter I of this thesis describes the purpose of this research study, defines key terms, and presents the research question. Chapter II contains a literature review that examines the PBL method and its impacts on teachers and student success. Chapter III concludes with a discussion about the overall findings, applications, limitations of the PBL method in the classroom, and possible avenues for future research.

Rationale

PBL methods are becoming increasingly used by teachers across the United States and internationally. In my own practice as a middle school Social Studies teacher, I have found that PBL techniques and teaching strategies offer students opportunities to go deeper into the topics about which they are learning while also promoting student engagement and self-efficacy. I,

however, was not the first to discover this. Wolk (2022) claimed that since the early 20th century - after Kilpatrick (1918) penned an article entitled “The Project Method” - educators like Dewey, Holt, Rogers, Atwell, Ashton-Warner, and Smith all promoted teaching methods that have lead to the PBL approaches utilized by so many educators today.

Despite the historical significance of PBL and its impact on education, there remains a need for further research on how this particular teaching method truly impacts teachers and students, especially in the area of secondary education. Additionally, PBL as a teaching method in the United States can often be seen as a teaching method that is more commonly used in alternative schools, such as Montessori schools or schools in the private sector. However, researchers like Wolk (2022) believe that PBL should not be confined to schools with more educational resources. “In 1991, Martin Haberman issued an urgent call to transform the “pedagogy of poverty” characterized by rote instruction, teacher lecture, seatwork, tests, and other practices common in classrooms for children in poverty” (Wolk, 2022, p. 28).

Internationally, schools are using PBL methods to not only teach students in content areas such as math and the sciences, but also to teach the English language to students who are English language learners. In China, Sun and Zhu (2023) studied how the implementation of project-based learning (PBL) can help English as a Foreign Language (EFL) students. In a similar study, Al-Bahadli et al. (2023) researched the impact this pedagogical approach had on EFL students in Iraq.

Definition of Terms

To better understand the terms used in this thesis, the following definitions are provided.

Project-based learning

Wolk (2022) defined project-based learning (PBL) as, “long-term investigations driven by real questions connected to the real world that result in authentic products that show student learning” (p. 26). PBL seeks to provide teachers and students with ways of co-learning the material that places the student in the “driver seat” of their own learning, with the teacher acting as the main support system throughout the learning process.

Teacher Practice

In this study, the term teacher practice is used to describe any part of the process of teaching and instruction within a classroom setting. Another term that will be used interchangeably with teacher practice throughout this study is pedagogy.

Authentic Learning

Authentic learning can be defined as any teaching method that promotes students to explore, dialogue, and thoroughly examine a topic in which they are required to collaborate and about which they ask “real world” questions in order to come to a satisfactory conclusion (Donovan et al., 2000).

Statement of Research Questions

The guiding question of this thesis is: How does project-based learning impact teacher practice and student academic understanding and engagement within secondary school classrooms?

Chapter II: Literature Review

This literature review focuses on 30 journal articles and studies that examine the impacts that project-based learning (PBL) has had on secondary education. These resources explain how PBL is utilized by teachers and students in various disciplines and professional learning communities. The research reviewed here also sought to understand the teacher's role in implementing PBL in the classroom, and how this method truly can lead to authentic student engagement and learning. The primary databases and resources that were used for this research were provided by the Bethel University online catalog and included the following databases: EBSCOhost MegaFILE, JSTOR Digital Library, ERIC, Google Scholar, and various other academic journals. The resource parameters set the years of publication of these resources between the years of 2018 and 2023 to ensure the relevance and accuracy of the current state of project-based learning (PBL) in education today. The goal of this literature review is to understand the impact that PBL has had on the teacher's role within the classroom, academic, and social growth among students, and whether this particular method of instruction can enhance student experience. Based on these three research goals, articles were then analyzed for content and themes that connected with the research goals. Although there was significant overlap of themes in many of the journal articles, upon further investigation the following six categories were formed to better interpret the overall findings of researchers and to achieve the research goals: teacher practice, engagement, authentic learning, self-efficacy, interdisciplinary study, and creativity.

Teacher Practice

When discussing the project-based learning (PBL) method, understanding how teachers can best provide instruction, as well as the challenges PBL presents are important considerations.

In a qualitative case study, Haatainen and Aksela (2021) sought to call attention to instructor's experiences when implementing project-based learning (PBL) and the advantages and disadvantages this teaching practice may present in STEM classrooms. The primary research question was, “How can PBL be implemented in integrated science education?” (Haatainen & Aksela, 2021, p. 155). The researchers then specified that this question later became three sub-questions: “1) What are teachers’ perceptions on the advantages of implementing PBL? 2) What are teachers’ perceptions on the challenges of implementing PBL? 3) What kind of elements of PBL are incorporated in teachers’ practices reported to the StarT programme?” (Haatainen & Aksela, 2021, p. 155).

The sample size comprised 244 teachers, 99 of whom were from the researchers’ home country of Finland; the other 149 educators hailed from 27 other countries, mainly across different parts of Europe. “Teachers represented various levels of education, from early childhood education to upper secondary schools” (Haatainen & Aksela, 2021, p. 156). This particular study contained two parts. One, the teachers first completed an online qualitative survey. Two, the researchers performed a case study based on the data provided by the survey.

Hattainen and Aksela (2021) mainly focused on the qualitative survey and the data that it provided to the StarT programme. The authors presented their data analysis in several sections. The first focused on the advantages of project-based learning in teaching practice. The main benefits teachers who participated in the survey cited as beneficial were the opportunity for overall learning that PBL provided for their students, varied opportunities for student collaboration, and students overall positive attitudes toward the projects they were asked to complete.

The second section of Haatainen and Aksela's (2021) data analysis focused on the disadvantages of PBL in practice that their survey group identified. Teachers who took part in the study claimed the most difficult part of PBL was the facilitation of student projects. "Furthermore, teachers reported issues with scaffolding instructions 'in balanced proportions, so that you don't restrict students too much but give opportunities and offer tools' (Teacher F52) and with students' inadequate skills and knowledge" (Haatainen & Aksela, 2021, p. 162). They concluded that teachers at any level have a vital role to play in the positive impact PBL will have on their students. The collected data provided evidence that most of the teachers understood what PBL was, but they struggled at times to assess and critique their students' work and final products. In the end, Haatainen and Aksela (2021) expressed that, "teachers see PBL as beneficial but need support with the implementation" (p. 149).

In a similar study, Potvin et al. (2021) sought to understand the enduring instructional shifts teachers make on a yearly basis when they or an entire school take up Project-based Learning (PBL). Their research centered on English Language Arts (ELA) teachers over a course of five years and sought to understand the scale of pedagogical adaptations these individuals made throughout that time period. Initially, this study supported 49 teachers using PBL across two different states; however, when the actual analysis of the data was conducted for this study, only seven teachers (five female, two male) were included in the published results of the study, each from a different school and with a different amount of teaching experience. "The schools were located in small city, suburban, and rural communities. Teachers had between 8 and 19 years of teaching experience; none of the teachers had prior experience with PBL" (Potvin et al., 2021, p. 4).

This study was conducted using mixed methods; data was collected using the following

procedures: classroom observation field notes, coaching notes, teacher interview transcripts, teacher surveys, teacher written reflections, instructional logs, and student interviews and surveys. In order to better understand the data that was observed, Potvin et al. (2021) used Coburn's (2003) concept of scale and the following four categories to organize their findings: depth, sustainability, spread, and shift in ownership. Potvin et al. (2021) claimed that, "Using an expanded notion of scale to include adaptation and reinvention provided opportunities to examine what changed and was sustained in teachers' classrooms over several years" (p. 3). Over the course of three different phases of analysis, the researchers discovered that scale was achieved by each of the participating teachers, but it was accomplished differently depending upon the educator.

Potvin et al. (2021) concluded that no matter how a teacher implements the PBL method, they will need to adapt and at times reinvent themselves and their lessons. "Scale through adaptation and reinvention occurred because of teachers' initiatives, which suggests that it is important to also support teachers in taking ownership of the reform and to highlight the ways teachers demonstrate that ownership" (Potvin et al., 2021, p. 11). The authors stressed the importance of considering instructional changes over an extended period of time, in order to ensure that the changes can be accurately accounted for.

Potvin et al. (2021) did account for limitations to their study. Namely, the small number of teachers who participated and the above-average amount of professional learning support these teachers received could have caused their conclusions to be skewed as their study did not take into account schools outside of the U.S. nor schools with less support. The authors' hope future research on these topics will be able to remedy the limitations of their study. "Ultimately, we consider it successful that teachers felt reinvigorated in their teaching and found aspects of

PBL inspiring enough to continue adapting and reinventing their curriculum and instruction" (Potvin et al., 2021, p. 11).

In an international study conducted in China, Sun and Zhu (2023) explored how the implementation of project-based learning (PBL) can help EFL (English as a foreign language) students form their overall competence in the English language. The two main research questions that Sun and Zhu (2023) used were:

> (1) What impact does project-based language teaching have on developing high school students' key competences in learning English as a foreign language? (2) What factors influence the project-based language teaching on improving high school students' key competences in learning English as a foreign language? (p. 5)

The participants in this study included two English teachers and 75 tenth-grade students who attend a high school in Qingdao, China. The project that students participated in took five months to complete and was composed of the following three phases: "a collective lesson presentation, a trial teaching, and a formal teaching" (Sun & Zhu, 2023, p. 5). The final PBL assignment asked students to create a presentation in which they would present on the topic of their hometown of Qingdao. The participating teachers were given a lecture on how to properly facilitate PBLT (Project-based learning teaching) and were allowed to exchange ideas with each other throughout the process.

This study used a mixed-method approach to collect its data. The data was analyzed in two phases:

> Firstly, a quantitative study using self-developed tests based on the English Competence Framework, and secondly, a qualitative study using students semi-structured focus group interviews, teachers semi-structured interviews, and teacher reflections triangulated the

> quantitative data and further explored the impact of PBLT on developing high school students' English key competences and factors influencing PBLT on improving high school students' English key competences. (p. 6)

Along with the English Competence Framework, the researchers also interviewed 10 of the participating students and two teachers. In order to measure the development of the students' English language competency, Sun and Zhu (2023) administered a pre and post assessment consisting of 11 questions. In addition each teacher wrote a personal reflection on their own experience with PBLT.

After analyzing their data, Sun and Zhu (2023), concluded that PBLT can have a positive impact on the development of English language competency in EFL students. Regarding their first research question, the authors found that students particularly excelled in the following six areas: attentiveness, summary, interpretation, application, argument, and creation. Regarding their second research question, Sun and Zhu (2023) identified five main factors that influence the effect of PBLT implementation on improving EFL high school student's English key competencies: "the teacher's understanding of PBLT, teacher's ability of designing and assessing the project, teacher's roles, teacher's instructions, and students' interest and motivation (p. 15). Overall, this study supports the claim that there are significant benefits in using PBL methods when instructing EFL students.

The impact that PBL teaching can have on student performance was further emphasized in the following study. In a quantitative case study, Saavedra et al. (2022) explored the impact project-based learning (PBL) methods had on teaching practice and students' performance on Advanced Placement (AP) examinations. The researchers implemented a cluster randomized controlled trial to compare and contrast the scores of students that were taught using PBL

methods and those that were taught using a traditional lecture-based AP approach. For this case study, Saavedra et al. (2022) partnered with three primarily urban school districts from different parts of the United States serving over 50,000 students. The researchers recruited 89 consenting teachers from 76 different schools to participate in this study. Teachers who participated in Saavedra et al.'s (2022) study had to consent to the following terms:

> Teacher eligibility requirements included: a minimum of 1 year of experience teaching APGOV [A.P. U.S. Government] or APES [A.P. Environmental Science] in their participating district prior to the 2016–2017 school year; scheduled to teach APGOV or APES during the 2016–2017 school year in the same school they were teaching in during study recruitment in 2015–2016 (i.e., their randomized school); if randomized to the treatment group, agreed they were able to attend the 4-day 2016 Summer Institute (though we included in our analysis as non compliers those who did not); and consent of the school principal. (p. 645)

Saavedra et al. (2022) did not specifically recruit or advertise to students or their families that this study was taking place in order to insure the validity of their findings at the end of the case study. "We restricted our student sample to include only those enrolled in their APGOV or APES class before December 2016, excluding those who enrolled in the course during the second half of the academic year" (Saavedra et al., 2022, p. 646). Data collected in this particular study included the final AP scores of the students who participated in both the APGOV and APES courses and whether or not the students earned a qualifying score on the subsequent exam.

Saavedra et al.'s (2022) research centered on the following two research questions: 1) What impact does PBL have on teacher instruction, learning materials and AP examination

scores? 2) How likely are students to receive a qualifying examination score when taught through PBL methods?

> 1) What is the impact of the offer of the AP PBL intervention—including curriculum, instructional materials, and professional learning supports as described—on student AP examination-taking and performance? 2) To what extent do differences in classroom instructional practices explain the relationship between teachers' AP PBL treatment status and students' probability of earning a qualifying score on the AP examination? (p. 644)

The results of this study seemed to confirm that the use of PBL methods had an overall positive impact on the preparation and scores of AP students. However, this method of teaching was not without its own set of challenges. "The AP context is particularly challenging because of the sheer amount of content covered in the course-specific AP curriculum frameworks and the looming end-of-year, high-stakes examination" (Saavedra et al., 2022, p. 660). To this point, the authors' investigation discovered the following changes to teacher practice: teachers focused their instruction on advanced thinking and communication skills, rather than the AP test "pre-assessments" and traditional assignments, and focused more on student-centered activities like simulated discussions.

Overall, Saavedra et al.'s (2022) findings seem to support the belief that the utilization of PBL teaching methods can improve the instruction and performance of both teachers and students, respectfully, who take part in an AP course. Their research also supports the belief that there may be a relationship between the PBL methods of teaching and the likelihood of students receiving a qualifying score. However, Saavedra et al. (2022) did note that further research

would need to be conducted in order to better understand any relationship between PBL instruction and higher test scores.

In a similar study that measured student competence, Giaffredo et al. (2022) investigated how the competence-based approach to education (CBE) can be implemented in secondary classrooms through project-based learning (PBL). Giaffredo et al. (2022) defined CBE as an approach to teaching that allows students to learn and progress forward in their mastery of a concept at their own pace. The researchers found a clear connection between CBE and PBL being that both approaches are student centered and allow student autonomy in their learning. They chose the topic of computer science (CS) as the discipline that would be used for their research as this topic often utilizes projects in its instruction. Because of this, Giaffredo et al.'s main research question was, "are CS secondary school teachers induced to adopt the CBE approach when they are applying the PBL method?" (p. 109).

Initially, the authors collected data from secondary teachers in the Trento Province of Northern Italy. This included information from 120 educators collected during two workshops and 300 additional teacher responses from an online survey. The authors conducted an action-research course and a collective study in order to evaluate student projects and interview the teachers about their classroom instruction activities and pedagogy. "We collected data and details on the project design: data related to competences to be developed by students during the project, and data about how students were going to be assessed" (Giaffredo et al., 2022, p. 109).

Seven CS teachers participated in the action-research training course, and all were asked to plan and use at least one project for their class. Data was collected at the beginning and end of the course to see whether the training provided by the researchers in both CBE and PBL had an impact on the participating teachers. The results of the action-research training suggested that

there was an overall lack of comprehension of the course vocabulary and understanding of CBE and PBL which was an impediment to the teachers as they worked to create effective projects and instructional plans.

Giaffredo et al. (2022) claimed that the confusion and unfamiliarity of the vocabulary and concepts used in this study are not uncommon, citing a 2013 study that found many teachers and researchers are unclear about the actual definitions of competences and vocabulary unique to this teaching approach. One of the solutions to this problem that the authors proposed was to continue to provide teachers with professional development opportunities like their action plan in order to help them to continue to improve their understanding surrounding CBE and PBL. This led to the second study in which the researchers evaluated six student projects.

Unlike the first study, Giaffredo et al. (2022) did not provide any assistance or suggestions to the CS teachers who took part, rather they simply observed each teacher's practice and PBL methods that were used in their classroom. Giaffredo et al. (2022) claimed the results of the second study differed in that all of the main characteristics of the PBL method were present, but the learning goals and the manner of student assessment were lacking.

Overall, this study displayed that a teacher's understanding of the vocabulary and concepts is key in the successful application of both CBE and PBL. Without a clear process of assessing students and determining the goal of a student's learning, PBL methods are not as successful. Giaffedo et al. (2022) were encouraged, however, by the fact that in both studies all of the instructors were self-reflective of their own practice. The teachers noted this study not only encouraged them to use some of the new techniques but also increased their confidence in receiving feedback and support about these systems in the future.

PBL teaching methods are often utilized in many different disciplines within the academic arena. Cole et al. (2022) investigated how project-based learning (PBL) methods can impact student understanding of the lunar phases. The authors also took into account the demographics (i.e., gender, ethnicity, spatial thinking ability, content knowledge) of the students and STEM teachers who were instructing them. The research subjects for this study were 399 sixth-grade students (and their teachers) who attended schools in the southeastern United States. All eight teachers who participated in this study were Non-Hispanic, White females. All of the teachers involved in this study received professional training on how to correctly instruct students about the lunar phases using the PBL method.

Cole et al. (2022) described the lessons teachers would give in the following manner: "The unit was designed to give students experiences with spatial geometric activities where lunar phases can be explored through direct observations, journaling, illustrations, 2D and 3D modeling tasks, and classroom discussions" (p. 4). The authors utilized two quantitative assessments to measure student understanding, the Lunar Phases Concept Inventory (LPCI) to test student knowledge of the unit topic and the Purdue Spatial Visualization Test: Rot (PSV-Rot) which tested student's level of spatial comprehension. "The two instruments were administered to both students and their teachers before and after the implementation of the PBI" (Cole et al., 2022, p. 4).

This study not only tried to understand whether PBL teaching methods could actually improve student test scores but also aimed to know whether there was any correlation between the teacher and student demographics and the student performance on assessments. The results did seem to confirm two things. One, the PBL methods that were used seemed to improve student understanding of not only the lunar phases but also student comprehension of spatial

thinking. “The findings also identify contextual factors from teachers (such as teachers’ content knowledge and spatial thinking ability) which contribute significantly to student content knowledge of lunar phases, thus establishing a connection between teachers’ domain-specific content knowledge and student’s understanding” (Cole et al., 2022, p. 7).

Two, the demographics of the students and instructors do affect students' performance on assessments. According to Cole et al. (2022), two student groups, those who self-identified as Hispanic and those who identified as Other, displayed significantly lower scores than their White peers. The researchers proposed this could have been because many of the students that identified as Hispanic or Other were English language learners and this presented a challenge to their learning. The authors also noted that the amount of Hispanic and Other students who participated was rather small (22 and 35 out of 399), which could have factored into the lower overall scores. Cole et al. (2022) proposed that, “Having larger groups within each race/ethnicity category besides White would add to the meaningful interpretation of a similar study in the future” (p. 7).

Overall, the authors concluded that because of the improved scores in both LPCI and PSV-Rot by both the students and teachers, the PBL method can be an extremely useful approach to teaching students as they “provide an active, engaging learning environment with challenging, relevant, and purposeful instruction” (p. 7). In addition the authors also concluded that in order for PBL to be successful, the teachers who implement it need to be properly trained in the specific teaching methods and have a strong understanding of the content.

Correspondingly, Sivia and Britton (2021), examined how teacher professional learning (TPL) is impacted by a schoolwide implementation of project-based learning (PBL). Similar studies have been conducted when a school has implemented this type of program, but this

particular study chose to focus solely on the teacher's experience rather than that of the students. The researchers explained, "our intention in this study was to understand how teachers perceived their learning as they developed their practices over the course of implementing the PBL innovation" (Sivia & Britton, 2021, p. 124). The authors criteria for a teacher to participate in this study included the following: 1) At least two years of experience instructing students using the PBL method, 2) An interest in sharing their thoughts about implementing PBL, and 3) a willingness to participate in the entire study. Originally, four 9th-grade teachers were involved, but by the end of the data collection process only two of the teachers were available to complete the study.

The data for this study was collected from many different sources including: semi-structured interviews with the participants before and after the implementation of the PBL units; observations and field notes during collaboration discussions; and researchers' reflections following each collaboration (Sivia & Britton, 2021). The initial interviews were conducted at the beginning of semester in January of 2017, and then a second set of interviews were completed in June of 2017. Sivia and Britton (2021) analyzed the data by synthesizing the teacher's responses to the interview question with their own observations through the field notes they had collected throughout the semester. Their hope was to find commonalities in the data set in order to find out the impact that this experience had on the teachers who were sampled.

Sivia and Britton (2021) categorized their eventual findings into three categories: 1) what they learned about TPL from this study, 2) how inquiry as a practice has been clarified through the experience of the teachers interviewed in this study, and 3) how they will apply what they learned to their work as teacher educators.

Regarding TPL the authors found that some of the key elements of TPL in this context were a learning mindset, collaboration, and flexibility of practice. The researchers defined a learning mindset as that which "draws largely on intrinsic motivation, or a deep desire to learn about and from one's practice as an educator (Sivia & Britton, 2021, p. 135). This element also leads to collaborative work and learning between teachers which is another element that Sivia and Britton (2021) observed. "As this study revealed, it was through collaboration between teachers implementing PBL that collegial relationships, a sense of solidarity, and continual refinement of their practice occurred" (Sivia & Britton, 2021, p. 135). Finally, through both their own observations and responses from the teachers in the study, the authors found that the teaching approach of PBL not only includes a need for teachers to adapt and change their practice throughout the year but also gives them a sense of freedom to instruct their students as they would like.

In the second section of their results, Sivia and Britton (2021) examined how inquiry and the practice of continuing to ask questions and encouraging students to do so as well can empower teachers. One of the teachers stated in his post study interview, "I am a lot more confident in the classroom…I am very present, I am in every moment, I'm not sure that was true five years ago" (Sivia & Britton, 2021, p. 136). In addition, the authors observed that emphasizing inquiry in TPL also helps teachers add more inquiry-based practice to their lessons and curriculum which has been shown to benefit students. The researchers for this study are both educators themselves and work with "In-service" and "Pre-service" teachers. Through this study, Sivia and Britton (2021) concluded:

> …that cultivating a disposition where teachers are 'learners of learners' would benefit teachers who intend to implement curricular innovations in their classrooms. This may

> include opportunities for students to provide feedback to their teachers about learning activities, as well as teachers assessing what practices promote student engagement and achievement. (p. 136)

Overall, the authors found that teachers need to have professional development opportunities on their own terms and in an environment that allows them to collaborate with other teachers and administrators.

De Beer (2019) examined what project-based learning (PBL) and classroom action research (CAR) can offer students and teachers studying the Natural Sciences. The author defined CAR as, " midway between teacher reflection at the one end, and traditional educational research at the other" (De Beer, 2019, p. 71). The research presented in this study utilized the lessons and observations, collected in portfolios, of 18 science teachers from the Northern Cape (Namaqua district) in South Africa. Interviews were conducted with each teacher to discuss their personal experience with both PBL projects and the CAR method, and all interviews and portfolios were transcribed and analyzed. De Beer (2019) summed up the data collection process in the following way:

> All submitted portfolios, which included teachers' reflections on CAR, were analyzed. I utilized Saldana's (2009) coding technique. In-vivo codes (codes taken from the exact words spoken by the participants, or captured in the portfolios) were identified and grouped into categories, and from these categories, emergent themes were identified. (p. 72)

The following three themes emerged out of the data collected: 1) Learner experience in both PBL and CAR was highly important to this study. 2) CAR and PBL assists science teachers in

becoming more critical in their personal reflections. 3) CAR could enhance teacher self-directed learning.

This study mainly focused on interviews and teacher's personal reflections; many of the teachers in this sample used research questions that focused on how their students engaged and improved over the course PBL project in order to measure this method's effectiveness. "Teachers obtained data to answer their research questions through the application of questionnaires, studying artifacts (learners' projects), and arranging focus group interviews with the learners" (De Beer, 2019, p. 73). Eighty percent of the teachers found implementing PBL projects in their classrooms lead to a new sense of energy, excitement, and inspiration from their students. This was encouraging to both the author and the teachers involved in the study as all instructors hoped their learners would be excited and engaged in the projects and lessons teachers design for them.

De Beer (2019) found that a key area where many teachers lack in their practice is in self-reflection. The researcher claimed that this can be due to time constraints (e.g., curriculum responsibilities, classroom administration, student engagement as well as teacher to parent communication). However, De Beer (2019) was encouraged that the CAR reflections provided by the teachers exemplified thoughtful and refined self-analysis. One teacher observed the following about the implementation of the PBL project: "When my learners presented their projects to the rest of the class, I could not believe that these were the same kids that were so disinterested in the work a month ago" (De Beer, 2019, p. 75). The author credited these and similar findings to the CAR method used in this study.

The third theme that emerged centered not only on student learning through the PBL method but also the self-directed learning experienced by the participating teachers. Although most of the teachers expressed nervousness about implementing CAR at the outset of the project,

the majority of the sample found the self-reflection required by the portfolios led to significant improvement in their own content knowledge and ability to instruct their students. This seemed to indicate that, “CAR assists in the development of teachers’ reflection skills, and that it could also enhance self-directed learning” (De Beer, 2019, p. 76).

De Beer (2019) concluded that although CAR has some limitations, it can be an effective way for teachers to self-reflect on their own practice and student engagement. Overall, his method was most impactful when CAR was scaffolded for teachers, with the teachers completing their research in clearly defined steps. Additionally, this form of professional development was most impactful when teachers were able to collaborate with one another. According to De Beer (2019), “Teachers engaging in CAR need ‘critical friends’ with whom they can share ideas” (p. 77).

Juuti et al. (2021) sought to understand the impact that project-based learning (PBL) can have on student learning and engagement in secondary education. For this study, the authors used teacher research partnership (TRP) to assess what the teachers were learning in professional learning (PL) settings about PBL units within their own classrooms. This study took place over the course of a three-year partnership between the authors of the study and participating educators. The participants included 20 teachers from both the United States and Finland who participated in the activities and PL opportunities described in the study. Six of these teachers implemented their co-designed PBL units and collected the data from their middle or high school chemistry or physics students. Juuti et al. (2021) used the following three research questions for their study: “1) To what extent do the student-reported frequencies of PBL features change? 2) To what extent does student-reported engagement associated with the features of PBL change? 3) To what extent does student-reported engagement change?” (p. 631).

The researchers evaluated the participants by observing how well the teachers were able to engage students through the PBL method. “Data [was] collected on the PBL features included in the teachers’ units and the extent to which the students found the situations engaging in order to co-reflect with the teachers on their enacted units” (Juuti et al., 2021, p. 632). The authors used a questionnaire based on the experience sampling method (ESM) in order to understand the student experience of specific scientific practices during the course of the case study. The ESM questionnaire required students to share what scientific disciplines they studied, whether or not they used a computer, and whether they worked in a group or individually. Juuit et al. (2021) used the following criteria in order to determine whether a student was engaged with the material:

> A student was interpreted as engaged when the questions relating to all three variables were answered “agree” (3) or “strongly agree” (4), and the binary variable for situational engagement was assigned a value of 1; otherwise, the variable was assigned a value of 0, indicating a low level of engagement. (p. 632)

This data was collected during the academic year of 2015-2017. The questionnaires were sent to students' smartphones that were engineered to send notifications to students to complete the questionnaire a total of three times throughout the course of the case study. In the end, the entire student data sample consisted of 3,518 responses to the questionnaire from 229 students over the three years.

After evaluating the student data, Juuti et al. (2021) and the teachers involved in the study concluded that not only is PBL an effective method of engaging students in scientific learning but that teacher interaction and co-design through theTRP method is extremely beneficial to teacher practice. The authors proposed that effective implementation of PBL has less to do with

the frequency of the use of PBL features in the classroom and more to do with how the teacher presents or scaffolds each part of the PBL unit. In implementing this form of pedagogical practice in the classroom, the authors emphasized that it is important for teachers to feel supported by research based practices and feel that they have co-teachers and colleagues that they are able to partner with. Basically, "The idea is not to adopt certain teaching methods or approaches but to learn how to implement research knowledge in everyday lesson planning, lesson delivery, and reflection" (Juuti et al., 2021, p. 638).

In a similar qualitative study, Arantes do Amaral (2021) explored the idea and impacts of using project-based learning (PBL) to teach a course on PBL. The participants in this study were 33 graduate students from the University of São Paulo, Brazil who were all part of the institution's Faculty of Education. The sample group included 13 men and 20 women, ranging from the ages of 22 to 49 years of age and who were not only graduate students but also teachers at both public (n = 6) and private schools (n = 27). The PBL course used in this study asked the students, while working in groups of five, to create a book about PBL using the PBL method. "The course was structured into four different development phases, each including one or more project deliverables; these were: preparation, planning, execution/control, and closure" (Arantes do Amaral, 2021, p. 3). The author also used Larmer et al's. (2015) PBL design elements which included the following seven principles: 1) the course should try to answer a challenging question; The product created should be both (2 authentic and 3) public; the course should create (4) sustained inquiry, (5) reflection, and (6) critique and revisions; and the students should be provided opportunities for (7) voice and choice.

Arantes do Amaral (2021) used three methods to collect the data from participants: an electronic survey completed by the students, students' projects websites, and focus group

discussions and activities. After the data was collected from the electronic survey, the author then categorized the findings into five recurring themes: 1) The course encouraged research about PBL methodology; 2) The hands-on method of PBL improved learning; 3) Activities in the classroom encouraged reflection in the learning process; 4) Writing about PBL encourages students; 5) The critique and revision process encourages learning. Analysis of the data provided in this part of the study seems to conclude that PBL is a method of teaching that is both effective and challenging. The students involved in this study said that, “to create the book chapter, they had to research both project-based learning methods and schools' experience of implementing PBL” (Arantes do Amaral, 2021, p. 3). This led to the development of the recurring theme that in order for the research to be conducted efficiently, students needed to develop communication, teamwork, and organization skills. Because the students were actually using the PBL method to learn about PBL, it provided each group ample opportunity to reflect on the methods being used in each activity of the course, and the students were also able to reflect on their own learning through writing activities. According to one student interviewed in the process, “critiques were always welcome: they helped us to identify flaws. The professor’s critique also guided and oriented us” (Arantes do Amaral, 2021, p. 11).

The second method of data collection, students’ project websites, provided the author with a sixth recurring theme: 6) The students explored the ideas of PBL methods, academic writing, and project management. “Students wrote on their website that, besides researching PBL methodology, they also had to look into academic writing and project management during the project” (Arantes do Amaral, 2021, p. 11). Finally, the third method, focus group discussions and activities, provided the researcher with two final themes: 7) Completing the survey and updating the project websites encouraged reflection on the learning process, and 8) The amount of work

required by this course was considerable. Students commented that the practice of updating their project websites each week fostered a habit of reevaluating their own ideas and understanding. The author also discovered that this PBL course and this method of teaching in general calls for a great deal of effort from the students involved. Arantes do Amaral (2021) when in discussion with the participants learned the following:

> According to them, they lacked training in research methodology, which hampered the process of writing a book chapter. Students also stated that the professor's demands for corrections led to an impressive amount of rework, and that meeting the weekly requirements of the course was extremely stressful. (p. 11)

In the end, the participants felt that the course's objective of creating a book about the PBL method was not only an excellent choice for the course but also motivated them to work to develop the project as best they could. However, most of the participants also reported that the amount of work that was required of them was taxing and led to some of the students experiencing a high amount of stress. Eventually, the book the graduate students created through this program was published and is now being used as a reference by the Education Faculty on effective ways to implement the PBL method.

Engagement

Student engagement is one of the ways that educators and researchers alike gauge the effectiveness of any teaching method. In a mixed-methods case study Reid-Griffin et al. (2020) investigated how project-based learning (PBL) can impact the community engagement of middle school students. This study took place over the course of two years at a rural middle school in the south-eastern United States with students between the ages of 11 and 12. Reid-Griffin et al. (2020) sought to answer the following two questions with this study:

> 1) Does working in a community of engagement setting, which is a learning environment that promotes students engaging in collaborative discourse as they work on a problem or project, influence rural middle school students' perceptions of social interactions? 2) How might Project-Based Learning instruction impact middle school students' self–efficacy, interests and engagement in the classroom? (p. 5)

The first year of the study was a pilot program and focused on sixth-grade students. The second year of the study included the same students who at that point had matriculated into the seventh grade as well as a new set of sixth-grade students. Students worked in groups of four during all of the projects. These groups consisted of at least one female student per group and at least one high-achieving student.

To gather the data from the students, Reid-Griffin et al. (2020) employed surveys, classroom observations, and interviews with the students who participated. "The quantitative measures used in both Year 1 and Year 2 of the case studies involve a modified Self-efficacy scale by Bandura (2006)" (Reid-Griffin et al., 2020 p. 10) In the first year of the study, "Student interviews consisted of informal conversations about their thoughts about working together on the projects and their interests in the subjects learned from the PBL projects" (Reid-Griffin et al., 2020, p. 10). The projects students created were based on what they were learning in a wide range of disciplines, and the collected data was based on the students' final presentations of these projects.

In the second year of the study Reid-Griffin (2020) modified their self-efficacy scale from 0-100 to 0-10 because teacher and student feedback indicated that the original scale was difficult to respond to. Just like in the first year of the study, students were interviewed about their presentations, but in the second year they were randomly selected due to time constraints.

“Randomly selected students were asked questions during the presentations of their PBL projects. The questions related to their thoughts about working together on PBL projects and their career interests” (Reid-Griffin et al., 2020, p. 10). The second year of this study's main purpose was to investigate not only the impact that PBL teaching methods had on the students but also the accuracy of the self-efficacy scale employed by the researchers.

Overall, Reid-Griffin et al.’s (2020) findings seem to confirm that PBL methods do allow students to engage in collaborative learning within their classroom community. “Through this instructional approach, middle school students were able to learn interdisciplinary curriculum and create their own learning communities” (Reid-Griffin et al., 2020, p. 19). The researchers found that teacher support was essential for student success as they provided not only academic assistance but also constructive feedback as students put together and presented their projects for each class. Both sets of students presented their projects in a public forum in the school’s gymnasium and library and later were given the opportunity to share their thoughts about the overall experience in an interview. Reid-Griffin et al. (2020) believe that in future studies of this nature, researchers should compare the data collected in this study with their own to further link the benefits of self-efficacy as one of the positive impacts of PBL.

In a similar, quantitative study, Carrabba and Farmer (2018) investigated the impacts that project-based learning (PBL) has on the overall motivation and engagement of middle school science students. The participants in this study were composed of two different groups of 631 middle school students from a Tennessee school district. Students from the 6th, 7th, and 8th grade, both male and female, and from a variety of different ethnic groups participated. Each group was instructed using a different method. Carrabba and Farmer (2018) randomly selected one teacher per grade to employ PBL and one teacher to use direct instruction. “The teachers

from each grade employed their respective type of instruction for one month, focusing on the same science standards. All student participants completed the Intrinsic Motivation Inventory [IMI] to assess their levels of motivation prior to and after instruction" (Carrabba & Farmer, 2018, p. 167). This study was guided by the following three research questions: 1) Is there a difference in the intrinsic motivation of students before and after the implementation of project-based learning and direct instruction? 2) Is there a difference in the engagement of students before and after the implementation of project-based learning and direct instruction? 3) Is there a difference in the intrinsic motivation and engagement of middle school students before and after the implementation of both project-based learning and direct instruction?.

The acquired data focused on each of the three research questions. Their analysis of the quantitative study found that students who participated in direct instruction scored significantly lower IMI than students who received their instruction using PBL methods. Regarding the second research question, students who participated in the classes using PBL methods showed higher levels of motivation. The data results of this case study indicated that student motivation and engagement levels improved when students were instructed using PBL methods as opposed to direct instruction. The researchers found implementation of PBL ($M_{after} = 3.68$) was higher than engagement before the implementation of PBL ($M_{before} = 2.86$), suggesting an increase in engagement after PBL instruction. The authors also discovered that the data result of comparing student engagement before and after direct instruction was also significant, $t(132) = 2.59$, $p = .011$. Student engagement after direct instruction ($M_{after} = 2.88$) was lower than student engagement before direct instruction ($M_{before} = 3.05$). "Specifically, intrinsic motivation significantly decreased after direct instruction whereas student engagement significantly

increased after project-based learning and significantly decreased after direct instruction" (Carrabba & Farmer, 2018, p. 172).

The authors also cited several other studies (Ateh & Charpentier, 2014; Ferlazzo, 2015) that came to similar conclusions on this topic. Carrabba & Farmer (2018) noted that this data suggests an additional benefit for student learning and teacher instruction. That is, students who adapted to the PBL learning environment at a more rapid rate found the increased rigor that they required and students who needed more time to become acclimated to the new type of instruction were provided the needed scaffolding from their instructor. "Students today need more opportunities to be autonomous with their education and project-based learning meets this need. Making choices in their own educational experience reduces apathy and increases motivation" (Carrabba & Farmer, 2018, p. 172).

Imbaquingo and Cárdenas (2023) conducted a mixed-methods study in order to determine the effectiveness of PBL on the ability of students studying English as a second language. The primary goal of this study was to increase student engagement with the course material by increasing student interest in reading and their overall understanding of the English language. Imbaquingo and Cárdenas (2023) believed that a key problem within this discipline was the overall lack of interest in reading and learning of English by students which negatively impacts their language comprehension. The authors hoped that by implementing PBL methods and projects in the classroom they were studying, they would be able to observe the overall positive effects of this teaching and learning method.

The subjects for this study were 20 ninth-grade students (11 boys, 9 girls) in a school in the capital city of Ecuador, Quito. The students within this classroom came from low-income families, had few technological resources available in their homes, and were required to work in

order to help their families' economic situations. Although these students faced adversity, they were still able to find success in their educational pursuits. “But despite this, the educational center provides the necessary resources for them to study and carry out their academic task in the institution " (Imbaquingo & Cárdenas, 2023, p. 10). Additionally, 10 teachers (two English teachers within the school, eight from other institutions) as well as two administrators participated in the study. Imbaquingo and Cárdenas (2023) assessed students using the following criteria: “ participation, group work, use of digital tools, motivation, content appropriateness, and reading skills” (p. 10). The researchers then had the teachers and administrators complete surveys about the participating students utilizing the same criteria used to assess the participating 9th-grade students.

Imbaquingo and Cárdenas (2023) used an evaluation sheet and surveys in order to analyze the situations, attitudes, and skills gained by the students on both an individual and group level. The observations and opinions of the teachers and administrators were also collected in order to assist in the overall evaluation and conclusions made by this study. After analyzing the data, the researchers concluded that the PBL is particularly effective at promoting English language learning and reading comprehension. “Students can read and comprehend English texts related to their interests by engaging in projects, increasing their motivation and confidence in their language skills” (Imbaquingo and Cárdenas, 2023, p. 17). The authors also highlighted the fact that PBL allowed students and teachers to have greater flexibility within the learning environment, providing students with multiple ways to express their learning and teachers opportunities to differentiate their instruction.

Imbaquingo and Cárdenas (2023) found that by applying the PBL methodology teachers were able to effectively use activities such as short fragments, stories, and legends from their

students' culture in order to promote student motivation and engagement with the material. Additionally, the authors concluded that PBL promoted better academic performance from the students, “As a result of the application of PBL, better academic performance was evident as it allowed planning, executing, and evaluating activities to promote reading and learning of the English language” (Imbaquingo & Cárdenas, 2023, p. 17). The researchers found that 80% of the teachers surveyed in this study believe that utilizing PBL reading activities help motivate students to participate at a higher level. The researchers concluded the PBL method used in this study highlighted the overall benefits and positive impacts that this method can have on students' critical thinking, teamwork, and engagement in the subject of English language learning.

Almulla (2020) investigated the effectiveness that project-based learning (PBL) had on engaging students in education. This study focused on teacher practice rather than simply PBL curriculum. This study was quantitative as it utilized questionnaires in order to gather the responses of those involved. The researcher analyzed 124 questionnaires; the sample size included 65 male and 59 female teachers. The educators were between the ages of 25 and 51 from diverse teaching disciplines and backgrounds.

Almulla (2020) identified five features of the PBL method: “collaborative learning (CL), disciplinary subject learning (DSL), interactive learning (IL), and authentic learning (AL), which, in turn, produced student engagement (SEL)” (p. 2). The questions included on the questionnaire reflected these factors; the first four were included in the first group of questions, and the fifth and only dependent factor, SEL, was in its own group.

Almulla (2020) hypothesized that the approach of PBL would have a positive impact on overall student engagement and comprehension. This study focused on students and faculty at the university level, an environment in education that PBL is rarely used. However, upon

analyzing the data that was collected by respondents, Almulla (2020) concluded the following: “The results of this study indicate that teachers’ understanding develops through the PBL approach, which may positively influence SEL” (p. 10). The author found the teaching method of PBL effectively uses the first four factors, CL, DSL, IL and AL which in turn enhance SEL. In addition, Almulla (2020) found PBL also supports student and teacher collaboration; it not only assists students in managing their studies but also creates a positive learning environment for both students and teachers. It also promotes authentic learning and questioning for students as they engage with more real-world problems through their PBL courses.

Almulla (2020) also emphasized that this approach has also been considered by scholars to be “constructivist.” The author noted that many university courses, whether online, asynchronous, or more traditional classes, most lend themselves to student collaboration and fully engaged inquiry and learning. Almulla (2020) claimed:

> Therefore, universities should encourage teachers to use the PBL approach. They should also make students aware, by utilizing this approach in the learning process, of the various advantages they can gain by using the PBL approach to considerably improve their educational achievements (p. 12).

The author hopes future research will continue to examine how teachers can better implement PBL teaching into their courses and overall pedagogical practices.

In a qualitative study conducted in the 2021-2022 academic year, Al-Bahadli et al. (2023) investigated the impact that project-based learning (PBL) projects and teaching methods had on students' engagement, motivation, and academic achievement while online learning. The sample for this study was composed of 100 randomly selected students attending Al-Kadhum University College who were taught using PBL methods in an English as a Foreign Language (EFL) course

during the first semester of the academic year. The instrument used to collect the data was a Likert questionnaire that was provided to students via various social media applications. “The questionnaire consisted of five aspects related to the variables used in this study, namely, communication, engagement, motivation, and academic achievement, in addition to the students’ subjective perceptions” (Al-Bahadli et al., 2023, p. 224). PBL was applied throughout the two month course and all of the participants were required to create and present a final project. Students participated in the class within groups of five but each created their own individual project which mainly consisted of PowerPoint presentations, with some students utilizing video, music, and songs to enhance their work.

This case study demonstrated some implications of the positive impact PBL methods can have on student communication, engagement, motivation and academic achievement in the classroom. In terms of communication, Al-Bahadli et al. (2023) found that 72% of the participants responded positively to the questions surrounding PBL’s impact on their overall communication in the course. Additionally, 69% claimed that method improved their engagement in the class, 69% said it positively impacted their motivation to complete the project, and 72% of the students believed that PBL was a key reason they enjoyed the course. Al-Bahadli et al. (2023) concluded, based on the provided data and final project scores of the students, there was a positive correlation between the participants' academic achievement and PBL. Essentially, “Project-based learning gives students the chance to interact extensively with the target topics, focusing on long-term retention rather than summative regurgitation and short-term memorizing. Because PBL can keep students interested, it also improves students' positive perceptions of their learning” (Al-Bahadli et al., 2023, p. 233).

In a mixed methods case study, Tierney et al. (2020) discussed how over a three-year period they redesigned a year-long project-based learning (PBL) Advancement Placement (AP) environmental science course to better engage high school students through the use of PBL and student centered lessons. The idea for this study had its roots in an earlier project known as the The Knowledge in Action Project. The parent project, which was developed collaboratively with researchers from the University of Washington Bothell, was designed to explore whether a completely PBL based course could successfully prepare students for AP exams. Tierney et al.'s (2020) study centered around the following driving question: "What is the proper role of humans in maintaining Earth's sustainability?, and each project challenged students to find answers to that question in a different authentic context" (Tierney et al., 2020, p. 76). Based on this single driving question, the authors developed and implemented three different studies. Each study had a unique set of participants, research questions, and data collection methods; because of this, the researchers evaluated all three of these studies individually to determine whether the redesign of the PBL was indeed effective.

The first case study took place over the course of two academic years (2011-2013) and focused on one teacher and her three high school AP environmental science classrooms. This teacher had ten years of teaching experience at the beginning of the study and had spent seven of those years teaching a non-PBL version of the AP environmental science course that was being evaluated. Tierney et al. (2020) also chose a school that was the most racially and socioeconomically diverse school in the district. In year 1 of the study, 48 high school students participated, "25 identified themselves as male, 21 as female; 35 students identified as white, 10 as Asian, 2 as Hispanic/Latino, and 1 as multiracial/ethnic; 35 spoke English as their native language" (Tierney et al., 2020, p. 78). In year 2 of this first study, 61 high school students

participated, “36 male, 23 female; 33 White, 12 Asian, 6 Hispanic/Latino, 5 African American, 3 multiracial/ethnic; 21 identified English as their native language and 21 did not disclose that information; 18 qualified for free or reduced-price lunch” (Tierney et al., 2020, p. 78).

Study 1 collected data via student interviews, meetings between the teacher and designers, and classroom video observations. Tierney et al. (2020) “looked for two kinds of evidence of the development of particular environmental citizen identities: students’ ability to articulate their roles in maintaining the environment and evidence that they were or were not transferring what they had learned to other contexts (p. 79). The student interviews were conducted both in small groups and individually. The authors categorized these group interviews as “fishbowl interviews” as four or five students were interviewed at the end of the course and were asked questions that centered around their experiences and their own understanding about personal responsibility surrounding the environment and sustainability. The authors also conducted four individual interviews during each year of study 1. “We sought a balance of gender, grade level, and racial diversity. Students were interviewed after the first unit (“cycle”) and at the end of each year, enabling us to look for changes in students’ attitudes and understandings over time” (Tierney et al., 2020, p. 79).

After these interviews were completed, the data was analyzed to assist the researchers in their overall redesign of the course. Tierney et al. (2020) discovered that the majority of the feedback from student interviews centered around an overall feeling of hopelessness surrounding the topic of sustainability. “As one student put it, ‘It was so depressing that you thought that there was no hope, so why would you care? … I wish that we could [learn] some things that you can do and be able to live with’” (Tierney et al., 2020, p. 82). Such feedback lead the authors to include the following three principles in the redesign for year two of the course: “1) position

students as change agents throughout the course, 2) arrange cycles in expanding spheres of influence, and 3) emphasize expansive framing for transfer" (Tierney et al., 2020, p. 82). In order to implement the redesign, the authors changed the first cycle of the course to focus more on the students personal families sustainability habits in the hopes that this would help students to realize their ability to be agents of change. This seemed to be a success as most students that were interviewed after the second year reported specific examples of ways that information learned in class was transferred to practices in their own homes.

The second principle of the redesign focused on students expanding their sphere of influence outside of their own home and into a wider community. "This expanding-spheres design provided access to understanding larger problems in the domain of environmental science while maintaining student agency through integral roles in projects and opportunities for self-expression" (Tierney et al., 2020, p. 82). The final principle that the researchers hoped to help students achieve in this course redesign was helping students develop understanding of the relevance of sustainability outside of the classroom. By the end of year 2, Tierney et al. (2020) concluded that the second group of students seemed to have a much deeper understanding of the real world application for what they learned throughout the course and how the topics discussed truly impacted their local and global communities. "In contrast with the first year, in which students felt they had not learned viable solutions, only one utterance in the second-year fishbowls indicated apathy, depression, or no perceived relevance" (Tierney et al., 2020, p. 85).

Following this first case study, Tierney et al. (2020) conducted a second study in order to analyze a broader sample of students and educators. In the second case study, 311 high school students (138 = male, 169 = female) from 18 different AP environmental science classes from two different school districts. They identified as the following ethnic groups: "One hundred

twenty-nine students identified as White, 61 as Asian, 40 as African American, 40 as Hispanic/Latino, 32 as multiracial/ethnic, 3 as Native American, 2 as Other/ Pacific Islander, and 4 undisclosed" (Tierney et al., 2020, p. 86). To measure the data collected in this case study, the authors utilized a survey that was scored using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). The survey focused on the following three concepts: 1) initial interest in the subject matter, 2) student engagement, and 3) perception of identity as an environmental citizen. The participants were surveyed twice, in the fall at the beginning of the course and then in the spring at the end of study.

The overall results of this survey study were considered alongside the results of the first case study. Tierney et al. (2020) concluded that, "Together, these findings provide support for the proposition that increasing students' opportunities for integral roles and self-expression in the practice of making science-informed decisions contributes to students' interest and, potentially, transfer to out-of-classroom contexts" (Tierney et al., 2020, p. 88). The authors claimed that these results not only support the idea that PBL curriculums are an efficient way to instruct students in AP environmental science courses, but also highlight the importance of these projects placing students in control of their own learning. However, the authors believe that the initial two studies did fall short in proving whether or not the course's design of gradually increasing the sphere of influence, from local to global, was supporting students' academic understanding. This was the catalyst for the researchers to conduct a third study.

In the final study, Tierney et al. (2020) sought to replicate and extend the findings of the previous two studies. The participants in the third study included 120 students from two urban school districts and 11 teachers from 11 different schools within the districts. "All teachers were new to the curriculum, although some teachers in both districts had experience teaching

environmental science or environmental studies courses" (Tierney et al., 2020, p. 90). The majority of the teachers utilized the PBL curriculum for the whole year; however, two teachers partially implemented it and one took longer than expected to complete the course. The data was collected using the methods employed in the previous two studies: group and individual interviews, and surveys. Surveys were again conducted by one of the researchers and took place at the beginning of the course in fall and at the end of the course in spring. The individual interviews took place in both the fall and spring; whereas, the group interviews occurred only at the end of the course.

After the data from study 3 had been analyzed, the authors concluded, "Both qualitative and quantitative analyses in Study 3 suggest that PBL-APES had a positive impact on the development of practice-linked identities as environmental citizens and engagement in classroom activities in urban classrooms" (Tierney et al., 2020, p. 93). Although the results found in study 3 were similar to the results found in study 1 and 2, the researchers claimed that study 3 allowed them to be able to examine whether or not the revised lessons were able to bring about a change in students' perceptions of their identity as environmental citizens. Interestingly, the data from study 3 supported the fact that partial implementation of PBL was less effective than full implementation in engagement of students and the development of their identities as environmental citizens. This discovery led Tierney et al. (2020) to propose the following:

> This finding, together with findings from Study 1, is consistent with our conjecture that the increasing-spheres design may have supported students' identity development by providing sustained and broadening contexts in which to practice their environmental citizen identities and that it was not just the impact of a powerful first cycle. (pp. 93-94)

In short, the findings of all three data sets seem to indicate not only a positive correlation between curriculum redesign and student engagement and understanding, but also an overall positive impact of PBL on students' academic knowledge and personal understanding.

Authentic Learning

A student's engagement has a strong correlation with a given student's academic learning. This has led many researchers to seek to understand how PBL can help students to learn authentically. In a mixed methods case study, Makkonen et al. (2021) tried to identify the positive and negative impacts of Project-based learning (PBL) on gifted secondary school students studying physics. One of the main reasons this study was conducted was due to the perceived lack of research on the benefits of utilizing PBL when teaching physics. Makkonen et al.'s (2021) three main research questions for this study were: "1) How do gifted students engage in learning physics in the PBL teaching module? 2) How do gifted students perceive their experiences of PBL? 3) What differences emerge in the learning outcomes of gifted students in the PBL compared with the traditionally instructed group" (p. 507)?

The sample size for this study focused on four groups of students between the ages of 15-16 years old who were taking a first year mandatory physics course. "Two groups (n = 23, n = 16) were randomly selected as experimental (PBL) groups and the remaining two were control groups (n = 26, n = 14). In other words, the groups were not built specifically for the study" (Makkonen et al., 2021, p. 508). Three main "instruments" were used to collect and measure the data from each student: a questionnaire, a scripted interview, and a cognitive test that measured student learning outcomes in physics. The questionnaire and interview questions were used to help answer the first and second research questions; whereas, the cognitive test was used to

determine whether or not the students using PBL method had better learning outcomes than the two groups that were instructed using the traditional teaching methods.

Makkonen et al. (2021) said, “The aim in this study is to investigate engagement, experiences, and learning outcomes among gifted students exposed to the PBL approach in their physics learning” (p. 507). The investigation resulted in three seemingly different conclusions. The first was in response to their first research question, how do gifted students engage in learning physics in the PBL teaching module? Makkonen et al. (2021) found that based on the questionnaire and interview question results, the majority of students enjoyed engaging with physics through the PBL method. “With regard to the preconditions for engagement the results show that almost all the students (95%) found it interesting to learn through PBL, whereas a considerably smaller proportion felt challenged (71%)” (Makkonen et al., 2021, p. 522).

Regarding the second research question, Makkonen et al.(2021) broke up the student responses into three sections: achieving objectives, comparison of two approaches, and autonomy. “The results indicate that creating artifacts and collaboration with peers in particular helped the majority in achieving the learning objectives of the module” (Makkonen et al., 2021, p. 518). Based on the questionnaire data, the majority of students who were instructed using PBL identified a considerable amount of benefits compared to more traditional methods of instruction, specifically their cognitive understanding of physics as well as their overall enjoyment in learning about physics. In contrast, Makkonen et al. (2021) found many of the students who were taught traditionally, “perceived it as being a more efficient way to learn, and many of them preferred reading and listening over practical experimentation” (p. 521). No matter the teaching method, all students explained that there was a benefit to some autonomy when learning about the topic of physics. “The findings also reveal that gifted students clearly benefit from

learning-related autonomy, but at the same time, some may need support that encourages autonomous behavior. In addition, more attention should be given to supporting collaboration among students during PBL" (Makkonen et al., 2021, p. 525).

Finally, the third research question sought to find out whether there were any significant learning differences between students who used the PBL methods as opposed to more traditional methods when learning physics. "In terms of learning outcomes, PBL enabled the students to perform at least as well as through the traditional approach" (Makkonen et al., 2021, p. 525). Although no significant statistical differences were found between the scores of the PBL group and the traditional group, Makkonen et al. (2021) claimed, "In sum, PBL proved useful in teaching physics to students with high abilities, and further studies examining its benefits could build on these preliminary findings" (p. 525). Some of the suggested further studies include: conducting a similar study with a more diverse group of students as well as conducting a future study over a longer period of time.

Knezek and Christensen (2020) researched the impact that project-based learning (PBL) had on middle school students' ability to understand and appreciate STEM (science, technology, engineering, and mathematics) subjects. According to Knezek and Christensen (2020), in the 21st Century the overall positive attitude toward science and technology from middle school students in the United States decreased and as a consequence so did the interest in sciences in both high schools and the amount of students that went into science and technology related fields. The overall purpose for this study was to try to recreate the findings of a similar 2009-2011 study through a similar quantitative research study that included the addition of a comparison group to attempt to determine students' feelings toward this discipline.

They sought to answer the following four questions: 1) To what extent do students involved in Middle Schoolers Out to Save the World (MSOSW) project activities gain in knowledge of energy and environmental science concepts. 2) To what extent do students involved in MSOSW project activities gain knowledge of standby power? 3) To what extent do aggregate dispositions toward science, technology, engineering, and mathematics (STEM) become more positive for MSOSW students involved in project activities? 4) To what extent do gender differences in STEM dispositions and content knowledge exist for students participating in MSOSW project activities? Knezek and Christensen (2020) conducted this study in two parts: the first began in 2009, and the second took place during the 2013-2014 school year. “The initial research phase for the MSOSW project included treatment data from classrooms in four states: Maine, Vermont, Louisiana, and Texas. The 2009–2010 year included data from 170 matched pairs" (Knezek & Christensen, 2020, p. 143). The researchers explained that for the second study, middle school students from other states and classrooms were added resulting in a total of 94 students in the treatment group and 235 students in the comparison group.

“The original study (Study 1) focused on treatment classrooms at the sixth grade level, while the replication study (Study 2) focused on treatment versus comparison classrooms at the same level” (Knezek & Christensen, 2020, p. 152). The analysis confirmed two things from both studies. One, the students who participated in the project began to think more broadly about the topics they had learned about during the three-week course. This was confirmed through student responses to the anonymous survey. Two, with each treatment, the students involved in the study increased, if only by a small margin, their understanding of the topic as well as in their appreciation for STEM.

Knezek and Christensen, (2020) noted, “While the impact was generally positive overall for those who participated, the effect was often more positive for females” (Knezek & Christensen, 2020, p. 152). The researchers went even so far as to say that they believed these findings can be directly correlated with the reduction in the gender gap in STEM careers in the United States. Overall, they seemed to propose that due the implementation of PBL within the discipline of STEM classrooms, students not only improved their comprehension of the topics but also improved their general attitude toward the subjects of science, technology, engineering and mathematics.

Chen and Yang (2019) took part in a study which approached the topic of project-based learning’s (PBL) impact on academic achievement by employing a meta-analytic approach to their research. The researchers were seeking to evaluate the majority of works and other case studies that had been conducted from 1998-2017 in order to understand the true impact that project-based learning could have on student achievement over time. Chen and Yang (2019) only included studies that fell under the following criteria: 1) Studies had to compare the effects of PBL with traditional instruction (TI) on students' academic achievement; 2) The research method needed to be based on an experimental approach; 3) The results must provide sufficient data (i.e., sample size, different grouping, mean); 4) Studies had to be written in English or Chinese. In the end, the authors used 30 different studies published over the previous two decades, “representing 12,585 students from 189 schools in nine countries” (Chen & Yang, 2019, p. 71).

Taking the results found in all 30 studies, Chen and Yang (2019) put all of the data collected on the impacts of PBL into the following seven categories: academic achievement, subject area, school location, educational stage, hours of instruction, information technology

support and group size. In terms of academic achievement, Chen and Yang (2019) found the following:

> The results indicate that students who participated in PBL had significantly better academic achievement than those who took part in [traditional instruction] TI, showing a medium to large positive effect on student academic achievement. These results are not exactly the same as those in Markham et al. (2003, pp. 5–6) and Thomas (2000), who presented rather conservative arguments about the effects of PBL compared with TI when they reviewed PBL studies. However, it is worth noting that Markham et al.'s argument was based on the evidence gathered in the previous 10 years at the time of writing (i.e., 1993–2002), and Thomas's was mainly based on research from the 1990s. (pp. 75-76)

In terms of PBL's impact on subject area, the authors found that PBL methods were far more impactful in the areas of social science (e.g., social studies, English, French and geography) than in the subjects of mathematics or science. Regarding school location, Chen and Yang (2019) found that students attending schools located in Europe, North America, and Western Asia were more significantly impacted by PBL instruction than students who attended school in East Asia. In terms of instructional stage, the authors found no significant differences in the impacts of PBL on whether students were at the elementary, middle, high or college level.

Chen and Yang (2019) did find a significant impact of PBL in terms of hours of instruction. "The results of post-hoc comparisons show that the effect of implementing PBL for above 2 h per week versus TI was significantly better than that seen with less than 2h per week" (Chen & Yang, 2019, p. 77). Data pertaining to access to information technology support was significant. Chen and Yang (2019) discovered that, "that PBL with the support of information technology had a better effect in comparison to TI than seen with PBL without this support" (p.

78). Finally, according to the authors, the size of a collaborative had no significant effect on students overall performance or learning, but the findings were still consistent that no matter the size of the group, the students that were taught using PBL methods fared better than those taught through TI. Overall, this meta-analysis gave compelling evidence that PBL has a significant impact on learners' achievement than more traditional teaching methods.

In their study conducted in 2019, Bowen and Peterson sought to discover ways to increase student engagement with subject matters that, in the past, may not have been as enticing. The researchers tried to create a space for students to interact with real-world problems giving students the opportunity, "to participate in authentic experiences, [and] they feel a sense of purpose and ownership over their learning" (Bowen & Peterson, 2019, p. 2). The researcher's chose mathematics as the discipline to assess in their study and collected their data from four 7th-grade classes in a STEM (science, technology, engineering, and mathematics) school located in the Midwest of the United States. The research focused on answering the following two questions: 1) Does using engineering-focused authentic activities result in higher student achievement in a 7th-grade mathematics class? 2) Does using engineering-focused authentic activities result in the understanding of the importance of slope compared to non-authentic mathematical activities?

The data collection method for this mixed-methods study included two instruments: 1) an academic-based assessment to test whether or not authentic activities truly improved student achievement, 2) an exploratory survey that used basic questions to ascertain the level of importance the students placed on the content learned during this study. The 53 students who participated in this case study were placed into separate groups. Twenty-seven students were placed into a control group which participated in a lab activity in which students were asked to

measure different objects around their school and calculate the slope of each structure. These students ended the activity by participating in a class discussion about slope, and then each student completed the posttest and survey.

The twenty-six other students were part of the experimental group. Bowen and Peterson (2019) based the experimental groups activities around the idea of authenticity by explaining to students the relevance of understanding slope in terms of engineering projects and problems. The experimental group PBL projects included three parts: discussion, practical application, and simulation. In the first part of the project, the authors described the project to the students participating in the experimental group using a Powerpoint presentation and discussion on the topic of structural safety. “Discussion regarding safety and the importance of properly designed stairs, handrails, and ramps was intentionally integrated into part one” (Bowen & Peterson, 2019, p. 4). Part two of the project asked students to take what they had learned in the first part of the project and apply it to similar structures present in their school. “The activity required students to determine whether the structures they measured did or did not comply with the given building codes, and to justify their answer” (Bowen & Peterson, 2019, p. 4). The final part of the project involved giving students the opportunity to construct and test their own version of stairs based on real-world scenarios provided by their teachers. The students then took the same posttest and survey taken by the control group.

Bowen and Peterson’s (2019) concluded there was little evidence to make the claim that authentic, PBL teaching methods improve student academic achievement, but it can increase a student’s understanding of the importance of a concept. The researchers' claimed the data showed few substantial differences between the posttest scores of the students in the experimental group and control group; only the overall mean score of the experimental group was slightly higher.

Bowen and Peterson (2019) concluded that one of the main reasons for this was the small sample size used in the study.

Regarding the students' perception of the importance of slope, the authors found a significant difference between the two groups. Bowen and Peterson (2019) claimed that statistically, the experimental group of student's responses to certain survey questions showed that the authentic approach can be very effective in promoting student buy-in. "This is further supported by the analysis between groups, which shows a significant difference in the means of the survey scores for the total score and Question 4 ('Knowing about slope will help me solve problems in the real world.')" (Bowen & Peterson, 2019, pp. 7-8). Therefore, although this study did not prove that PBL methods improve student academic performance, this approach to teaching does encourage student engagement by helping students understand the importance of the topics.

In this design-based research (DBR) study, Miller et al. (2021) examined how project-based learning (PBL) can motivate both students and teachers in their learning and practice. The participants included 200 teachers from across two states and 41 districts as well as a smaller focus group made up of 10 teachers. The focus group all had classrooms made up of African American and Latino students located in school districts in areas with high poverty rates. This was important to the study as the context in which the study was conducted helped form the development of the curriculum that was used as opposed to the more traditional curriculum design where students and teachers from low income districts and schools are considered after the curriculum is designed. The data was collected over the course of four cycles. "Data from the first cycle were used to reify initial design features to inform the re-development of materials for a larger second, pilot phase of implementation, involving significantly more teachers" (Miller et

al., 2021, p. 763). The other three cycles built upon the findings from the first cycle which informed the course of the rest of the study.

Miller et al. (2021) used multiple and varied sources of data for this study. These included field notes, large scale teaching trials, efficacy tests, and interviews. “Primary sources of data from the close ethnographic site included 86 semi-structured interviews that asked teachers to reflect on enactment of PBL features, and satisfying and unsatisfying aspects of a lesson directly after teaching it” (Miller et al., 2021, p. 765). Through the data that was collected, the authors developed three principles to describe their PBL framework: adaptiveness, responsiveness, and intellectual satisfaction. Through the data, the authors found the principle of adaptiveness was essential for meeting the goal of PBL curriculum. Interestingly, Miller et al. (2021) discovered a trend: “teachers would choose to abandon a lesson rather than adapt questions, sequences of investigations, or design problems to match their circumstances” (pp. 767-768). The authors used these findings to improve the professional learning (PL) opportunities they provided for their focus group. They also invited teachers to share examples of lessons they had adapted. By the end of the third cycle, all of the teachers in the focus group made changes to their original lessons with most experiencing positive results. Miller et al. (2021) discovered that by the end of the study, not only the teachers, but the students also began to understand the importance of adaptiveness in PBL. Furthermore, “Students also responded to the adaptation principle by learning more science; they knew the teacher might respond to their solutions, even if they were not written in the curriculum” (Miller et al., 2021, p. 769).

When analyzing the data for evidence of responsiveness, the researchers concluded that sustained interaction with the course materials was necessary for teachers to fully engage with responsive practices. All ten of the teachers in the focus group expressed a need for help in

making their projects and classroom environments more equitable for their students. “Teacher asked questions during the second cycle that had subtexts about equity and inclusiveness, ‘What do I do with my one student, no one wants to work with him. Can he work alone?’ ‘How do I get kids to stop talking and start listening to each other?’” (Miller et al., 2021, p. 770). In the following cycles, the teachers were provided PL opportunities that helped them to consider cultural responsiveness and develop equity goals within their lessons. Miller et al. (2021) noted one example of an equity focused lesson on the topic of social justice in science. In this lesson, students engaged with texts that focused on the need for trees in more impoverished urban areas. The teachers later commented in post-interviews that considering cultural responsiveness and underrepresented voices in their lessons transformed the way they approached teaching. “Explicit goal setting in PL toward culturally relevant teaching allowed the teacher to decide to bring in family, cultural, and community experiences to bolster knowledge building” (Miller et al., 2021, p. 771).

Finally, the authors truly wanted to understand if these lessons and projects could be both enjoyable and intellectually stimulating. This particular principle was not presented to the focus group until the fourth cycle of the study. Although joy in learning is important for both teachers and students to experience, Miller et al. (2021) admitted that it initially seemed like a fortuitous effect of the PBL method. However, upon further evaluation it was discovered that teacher’s believed that enjoyment and intellectual invigoration were commonly present in all successful lessons. Additionally, “students described feeling enjoyment during active construction of projects, practices that included aspects of play (i.e., acting out an animal’s structure), going outside or other active investigation, and sharing stories from their families” (Miller et al., 2021, p. 773). Based on all of the data that was collected over the five year period of this study, the

authors concluded that all three of the elements previously discussed contribute to a flexible, equitable and successful learning environment for all students and teachers.

In this quantitative case study, Lozano et al. (2022) sought to compare and contrast two methods, cooperative learning (CL) and project-based learning (PBL), to discover their impact on emotional intelligence of students when implementing sustainable development goals (SDGs). This study focused on four main objectives: 1) Analysis of the different impacts that the two methodologies (CL and PBL) have on student and teacher learning outcomes, 2) Analysis of the impact the two methods had on the emotions of high school science students, 3) An estimation of the correlation between emotions and active methods, and 4) Evaluation of student results in the learning environment surrounding SDG's 7 (affordable and clean energy) and 13 (climate action). The researchers chose the two SDG's in order to not only encourage their students to consider the climate emergency that exists but also encourage students to develop their social emotional learning skills through group collaboration on interesting and difficult topics.

The participants in this case study were composed of high school students and teachers in Spain participating in the e-WORLD Innovation Project. Lozano et al. (2022) described the overall purpose of this project in the following way:

> The e-WORLD project was carried out over twelve sessions on the subject of regional configuration of Castilla y León Science Laboratory of 4th ESO. This subject is based on student skills development that encourages them to become capable of exploring facts and phenomena; in this case, related to energy, analyzing problems, and organizing relevant information. (p. 4)

The sample included two classrooms consisting of 38 students (42% male, 58% female) who

ranged in age from 15-17. There was no control group used for this study.

Quantitative data was collected via a questionnaire, the main research tool that assisted in the analysis of the author's data. The questions were developed by a group of university professors who were experts in the teaching and learning of experimental science. The questions were later chosen and adapted into a second draft of the questionnaire. Lozano et al. (2022) broke the questionnaire up into the following two sections or blocks:

> Questions in block 1 used a 5-point Likert-type scale with values to measure the degree of perception/opinion/agreement about the statements made, where 1 was equivalent to "not at all/barely" and 5 was "a lot/totally agree." Questions in block 2 used the multiple-choice option. (p. 5)

As the authors assessed their findings, it became clear that the majority of the students participating in lessons using both the CL and PBL method responded with either medium or high scores on the questionnaire. Additionally, in order to understand the differences between the two learning methods the researchers utilized a pre and post test ANOVA test. "When these differences were significant, a Tukey's SHD test was performed to conduct binary comparisons between the groups and, therefore, to know which of the variables presented the highest influence [37,38] (Lozano et al., 2022, p. 6).

The final results of this study seemed to indicate to Lozano et al. (2022) that both CL and PBL are efficient methods of improving students' academic performance and increasing their enjoyment of meaningful learning. When comparing the two methods, the researchers found CL (as a method) allowed the students involved in this study to have achieved a greater amount of personal and group responsibility than PBL. However, the authors claimed the data suggested

that both of these active learning methods can be beneficial for students' overall cognitive and emotional improvement.

Self-efficacy

Under the umbrella of project-based learning (PBL) there are multiple different frameworks and ways of implementing this particular teaching method. DeMink-Carthew and Olofson (2020) developed a framework they call the Hands-Joined project in which students and teachers participate in a personalized learning experience and share the instructional power. They claim that the main difference between personalized learning and other forms of differentiated instruction "is that personalized learning requires teachers and learners to share power in deciding what individual learners will learn, how they will learn it, and how they will demonstrate their learning" (DeMink-Carthew & Olofson, 2020, pp.1-2). DeMink-Carthew and Olofson (2020) claimed that this sharing of power is not new to American middle schools but their study, "was intentionally designed to investigate the learner perceptions of middle grades students regarding a hands-joined learning project" (p. 5).

The sample size for this research study was a 7th and 8th multi-age social studies class in the most ethnically diverse public school in the state of Vermont. "At the time of the study, the school had been experimenting with personalized learning with teams, teachers, and classrooms at varying stages of implementation" (DeMink-Carthew & Olofson, 2020, p. 5). Including the instructor, there were 89 participants in the instruction portion of the study, and 81 of those students' parents or guardians provided permission for their student to complete a survey and share their work with the researchers. DeMink-Carthew and Olofson (2020) collected two types of data for this study: qualitative data (i.e., teacher journals and teaching materials) and

quantitative data (i.e., an anonymous survey) through which students gave feedback about the PBL project.

"This study focused on two questions about the extent to which the hands-joined learning project achieved two aims: (a) providing learners with opportunities for personalized learning and (b) providing learners with appropriate instructional scaffolding" (DeMink-Carthew & Olofson, 2020, p. 9). The authors of this study discovered that their hands-joined learning framework was an effective tool for the majority of the learners who participated in the study. DeMink-Carthew and Olofson (2020) claimed their analysis shows that the middle school they observed craved personalization and the freedom that this method of teaching provided. They also discovered that even within the scaffolding process, students should still be allowed choice. "We posit that offering opportunities for learners to make choices within the scaffolding process would further amplify student perceptions of playing an active role within the hands-joined learning experience" (DeMink-Carthew & Olofson, 2020, p.13).

The authors did account for some limitations to their study, citing that this study only looked at the benefits of PBL for one class, with one teacher, in one content area. DeMink-Carthew and Olofson (2020) proposed that it could be beneficial to do this same study with multiple teachers and classrooms at the same time, while covering multiple different kinds of disciplines. Overall, DeMink-Carthew and Olofson (2020) concluded that their hand-joined method in which teachers and learners share the power of choice in learning provides an opportunity for students to personalize their learning while allowing teachers to provide the appropriate amount of scaffolding and support. "Student feedback suggests that this hands-joined learning project was largely successful in achieving these goals, offering empirical support for

the assertion that project-based learning is a promising pedagogy for personalized learning" (DeMink-Carthew & Olofson, 2020, p.14).

In an action research study Becerra-Posada et al. (2022) sought to discover how Project-based learning (PBL) impacts students studying English as a Foreign Language (EFL) within secondary public schools in Cordoba, Colombia. Becerra-Posada et al. (2022) claimed that although research on how PBL methods impact EFL students have been conducted in the past, "more research in the area is needed, especially in contexts where students have basic English language proficiency levels and rarely have significant opportunities for L2 [Level 2] practice" (p. 14). This study was anchored by two questions: "(1) How do eighth-graders develop their communicative competence within a PBL instructional unit? (2) In what ways do eighth-graders build confidence during PBL lessons?" (Becerra-Posada et al., 2022, p. 15). In this study, communicative competence was defined as, "the use of spoken and written language as well as the interaction among speakers, listeners, writers, and readers" (p. 15). Self-confidence was described as, "affective principle that refers to the belief that one is capable of accomplishing a task" (p. 16).

The sample was composed of a single teacher's class of 32 eighth-grade students who attended a low-income school in the urban area of Monteria, Columbia. Becerra-Posada et al. (2022) described the student understanding as follows:

> The eighth graders were beginning English language learners who could understand familiar L2 words, translate simple sentences from their L1 to the L2, and name familiar objects. The students responded to the teacher's questions as a group and hardly ever participated individually in the lessons, arguing their lack of confidence to do oral tasks in English. (p. 19)

Students participated in a six-part PBL program that focused on teaching the students the English language through a project about food and nutrition. Students worked collaboratively to create a presentation that would instruct their fellow classmates on how to prepare a specific dish of food. The researchers used multiple research tools in order to evaluate the data from each student including classroom observations, field notes, interviews, and diary entries provided by the students.

Becerra-Posada et al. (2022) found that the change from traditional teaching methods to a PBL-based method helped the students improve their communicative competence in the English language as well as their own self-confidence about their understanding of the language. The authors claimed that PBL increased the students' level of communicative competence because, "the different stages in the PBL project gave the students the opportunity to practice language for communication since the overall project had a communicative goal: The description of a typical dish" (Becerra-Posada et al., 2022, p. 27). The authors also found that this method of teaching relies heavily on the teacher's ability to support and scaffold the lessons effectively.

> In the implementation of PBL, the teacher's role is fundamental since teachers provide students with opportunities to grow in the process and reach their final goals. This is even more relevant in students with basic language levels who are not daily exposed to the second language. (Becerra-Posada et al., 2022, p. 28)

Regarding the second goal, these PBL lessons did increase the students' overall enjoyment of learning the English language because the method by which they learned it was low pressure, interesting, and fun. "In fact, this cooperative work from peers and the teacher helped the students to reduce the social pressure they had when the project started and thus respond to the tasks" (Becerra-Posada et al., 2022, p. 28).

Hanham et al. (2020) conducted a study that sought to determine the role efficacy plays in project-based learning (PBL) groups composed of either friends or acquaintances. The 164 participants in this study were 8th-grade male students attending a high school in Sydney, Australia. Hanham et al. (2020) organized the students into two different groups participating in Geography, Religious studies, and English courses. Each group consisted of four students; 21 of the groups were made up of students who identified as friends, with a, "shared history, mutual regard, and strong interpersonal connections of group members" (Hanham et al., 2020, p. 133). The other 20 groups were made up of acquaintances defined as groups that, "generally involve people who have limited interpersonal knowledge and/or previous direct contact with others in the group" (Hanham et al., 2020, p. 133). The authors chose to identify two different types of efficacy for this study, collective and proxy. "Similar to self-efficacy, collective efficacy is domain/task specific and emerges over time in groups in response to inputs such as feedback and the perceived characteristics of group members" (Hanham et al., 2020, p. 134). The authors defined proxy efficacy as an individual's ability to see the usefulness in other members of a group with whom they are collaborating.

The research focused on the following three questions: 1) Are there significant differences between the performance of groups of friends compared to groups of acquaintances working on a group project within an academic setting?, 2) Are proxy efficacy and collective efficacy beliefs at all related to group performance in this context?, and 3) Are there statistically significant factors associated with collective and proxy efficacy and group type? The data was gathered using four versions of a questionnaire that corresponded with four roles represented in each group: coordinator, video producer, storyboard developer, and project developer. The levels of collective efficacy were measured with questions on an 11-point scale (0% = not confident,

100% =fully confident). The proxy efficacy scales were measured using a variety of different questions that matched each role in the group; this helped the researchers to be able to measure each student in each group accurately.

The results seemed to indicate that there may be a benefit for students participating in PBL group projects in a group composed of friends, for there was significant improvement in performance in the friend groups as compared to the acquaintance group. However, this was only found in Geography (one of the subjects assessed). Hanham et al. (2020) posited this may have been due to the final summative assessment, as a short video may be more conducive for a group of students with a stronger bond and ability to discourse at a higher level than a group of acquaintances. In terms of the second research question, there were mixed results whether collective and proxy efficacy impact a group project. Hanham et al. (2020) concluded that there was indeed a positive correlation between collective efficacy and the performance of all of the groups. However, the most significant example of this was found in only one of the disciplines, Religious studies. “It is important to note that collective efficacy did not predict group performance for the final multilevel models in English and Geography. This result may suggest the importance of context when examining efficacy beliefs” (Hanham et al., 2020, p. 141).

Regarding proxy efficacy, the authors found that most of the groups displayed overconfidence in their fellow group members abilities which lead to a decrease in their own efforts toward project completion. This negative correlation between proxy efficacy and group work could also be greatly impacted by the disciplines and contexts in which these particular students were observed. In response to the final research question, Hanham et al. (2020) noted:

> For the subjects of Geography and Religious Studies there appears to be a consistent pattern concerning the nature of the interactions involving collective efficacy and group

> type. In general, when collective efficacy was low, acquaintance groups scored higher on the summative tasks, and when collective efficacy was high, friendship groups scored higher on the summative tasks. (p. 142)

Additionally, there was a strong correlation between collective efficacy scores and proxy efficacy scores. Hanham et al. (2020) found that if one of these forms of efficacy was low, the other was most often high and could predict the overall performance of the group on the particular project. In conclusion, the findings suggest a correlation between positive student performance in PBL projects and friend group composition.

Interdisciplinary Study

Howard et al.'s (2020) case study focused on high schoolers, an often underrepresented group within pedagogical research. "Growing interest in and uptake of experiential, project-based approaches that undergird popular educational initiatives such as: 21st century teaching and learning; New Pedagogies for Deep Learning; and Global Competencies among others call for further research at the secondary level" (Howard et al., 2020, p. 635). So, researchers examined why there remains such a significant gap in secondary education research compared to its elementary and middle school counterparts.

The school at the center of this study was located in a suburb of Atlantic Canada, and the entire school took part in a project called the "What Does It Mean To Be Human" project which began in 2017. From there, the school administrators and teachers planned, coordinated, and assisted students in completing the school-wide PBL project which eventually culminated in a 2018 public presentation to educators participating in a professional development day. As mentioned, this study was conducted in response to a major gap in research literature about PBL's use in secondary settings, but Howard et al.'s (2020) research questions also centered

around the effects of a whole-school PBL project on student experience, attitude, and engagement toward learning.

Howard et al. (2020) focused on the lived experience of the students and staff who were participating in the "Big Idea" project. "In keeping with the experiential and the existential orientation of the research, a Qualitative Case Study (QCS) methodology was chosen that best aligned with these underlying orientations" (p. 625). Howard et al. (2020) chose to use two forms of data collection for both the students and teachers participating in the research; however, this particular journal article focused on the findings based only on the student data.Student surveys asked questions centered on the student's engagement, learning environment, and depth of content learning. Aggregated data was provided to the researchers in order to understand the changes that took place in the student experience throughout the duration of the project.

The authors also administered conversational interviews which were ethically held in a focus-group setting and were audio-recorded so student responses could be saved and transcribed after the collected data had been analyzed. The final results of the actual project resulted in a successful whole-school, project-based learning project that not only engaged the students and staff who participated in it, but also allowed for many interdisciplinary opportunities. The final exhibit presented to the public included PBL products (e.g., scientific ideas represented in artwork, written work that sought to display examples of human communication) and a collaborative effort between the Fine Arts, Leadership, Psychology classrooms that created a model of a brain that was as big as a classroom. The researchers' concluded, "wholeschool, project-based learning resulted in meaningful experiences for high school students" (Howard et al., 2020, p. 635).

Warr and West (2020) investigated how project-based learning (PBL) allows students to solve academic problems creatively while utilizing academic skills from different disciplines. Over the course of two years, Warr and West (2020) tried to answer the following two research questions: “1) How did students describe their experiences in the interdisciplinary design studio courses? 2) What did students describe as the primary challenges and opportunities of the interdisciplinary design studio?” (p. 7). Their hope was that by implementing qualitative research methods they would be able to collect a varied sample of data from multiple different groups of students that participated in creative and interdisciplinary design courses. Warr and West (2020) partnered with the universities Creativity, Innovation and Design (CID) group to collect qualitative data by way of interviews, observations, and surveys.

The 196 students who participated in this study attended a private university located in the United States. Students were interviewed both individually and in small groups. The interview questions posed to students focused on the structure of the course, what students learned and experienced, as well as the use of research and library spaces. Student interview questions focused on the structure of the course, what students learned in the course, students’ experiences in the course, and use of the library space and resources. Observations for this study focused on teacher-participant instruction and the interactions between students and instructors. All students who participated in the courses were invited to take part in the end-of-course survey; although the survey data was not tested, it provided further insight into the students’ experience.

To collect the data, Warr and West (2020) used three separate PBL projects over the two-year span. Each project allowed student choice in how they would accomplish their academic goals and also provided student collaboration opportunities. Because these projects were interdisciplinary in nature, Warr and West (2020) claimed that, “students developed

problem-solving skills beyond what they would normally build in a disciplinary studio course" (p. 10). Whether it was creating a documentary about societal change, the production of an augmented reality game to teach high school students scientific facts, or a year long collaborative project in which students sought to innovate solutions to community issues, all of the projects were student-centered and promoted creativity.

Warr and West (2020) found this method of learning provided students with a mix of challenges and opportunities not found in traditional courses. Students who participated in the courses found that they cared more about finding solutions to the "real world" problems proposed in the course than the course grade they actually received. Warr and West (2020) noted a response from one student that illustrated a common response from many participants, "The freedom that you are given as a student in the class to make it your own and decide what you want to work on makes the class particularly valuable" (p. 9).

The authors also noted some of the challenges students faced when participating in this interdisciplinary course. Students struggled at times to work collaboratively with others because of the limited feedback and direct instruction they received. Another challenge was due to students coming from different disciplines, as there were often scheduling and communication issues as well as differing project timelines with which students had to contend. Warr and West (2022) suggested the challenges described by students could have been solved by additional support and overall scaffolding provided by the faculty, especially toward the beginning of the course.

Overall, Warr and West's (2022) findings seem to indicate that this course not only provided a creative and engaging way to learn but also gave students an opportunity to experience what collaboration may one day look like in their future careers. "All in all, the

project-based courses in the CID studio moved learning beyond traditional courses and beyond intra-disciplinary studio pedagogy. They provided students instead with opportunities to experience first-hand the advantages and challenges of interdisciplinary creativity" (Warr & West, 2020, pp. 14-15).

In a qualitative case study, Virtue and Hinnant-Crawford (2019) discovered how students perceive the teaching method of project-based learning (PBL) by looking at student work across several different disciplines. The researchers partnered with the New Tech Network (NTN), which is a non-profit company focused on the professional development and training of their teacher's in the PBL method. The training provided by NTN, "allows teachers to learn the skills to implement PBL but gives them the freedom to develop projects based on their student and classroom needs. Frequency, scope, and scale of projects are determined by the classroom teacher" (Virtue & Hinnant-Crawford, 2019, p. 4). This program also provided teachers with training in interdisciplinary instruction and students that attend NTN schools learn content through integrated courses. This case study was part of a larger mixed-methods study which compared the academic outcomes of non-NTN students to students who were enrolled in NTN high schools.

The sample size included 28 high-school juniors from five NTN high schools who were all placed into focus groups that consisted of four to seven students. The research question used to guide their research was "What does PBL look like across the disciplines, and how do students perceive the impact of PBL?" (p. 5). During student lunch periods, Virtue and Hinnant-Crawford (2019) interviewed students about their favorite assignments and teachers, after being assured their comments and identities would remain anonymous. "All groups noted that they preferred projects (i.e., sustained time and inquiry) to assignments (e.g., worksheets and daily homework).

Participants were also asked to identify aspects of the school they did not care for" (Virtue & Hinnant-Crawford, 2019, p. 5).

Upon analyzing the data collected from the student focus groups, Virtue & Hinnant-Crawford (2019) synthesized the following three themes: 1) Some subjects work better with PBL than others; 2) Difficulty can sometimes outway the value of PBL; and 3) PBL can prepare students for the opportunities and challenges of future careers. The authors emphasized that in qualitative research studies like this one, student's voices are not only fascinating but also instructional. Overall, students displayed a high degree of satisfaction with the PBL method of teaching. "Satisfaction does not simply mean the projects are fun, but that students are able to articulate the value inherent in the approach" (Virtue & Hinnant-Crawford, 2019, p. 9).

Regarding the challenges that students expressed about PBL, Virtue and Hinnant-Crawford (2019) found that students expressed discomfort with being graded as a group and not as an individual as well as fear of the unknown. Many students expressed trepidation about digging deep into a concept over the course of several weeks, instead of the more traditional method of covering one topic per week until the end of the course. The researchers were hopeful that as PBL becomes more commonly used in educational spaces students will become more familiar with its structure and find some of these aspects less challenging.

The authors asked their fellow educators and stakeholders to truly listen and learn from their students. "Will we take the instruction from the voices of our students? Will we endeavor to provide an education that is truly satisfying?" (Virtue & Hinnant-Crawford, 2019, p. 9). The researchers hoped that as continued research similar to this study is completed, students, educators, administrators, and law-makers will truly be able to see the value in the PBL approach and how it, as an educational experience, can be instructive, engaging, and even fun. According

to Virtue and Hinnant-Crawford (2019), “To accomplish these goals, teachers must be adequately supported, value the PBL process, and work together in equal measure to prepare students for the project” (p. 10).

Creativity

Beyond improving teacher performance, as well as student learning and self-efficacy, PBL also seems to encourage creativity within the classroom. Fadhil et al. (2021) analyzed the impact that project-based learning (PBL) can have on the creative thinking skills and overall learning outcomes of high-school-aged students. This study sought to take a physics topic, namely vibration and wave creation, which in the past students may have considered boring when taught in a more traditional, teacher-focused style, and try to make it more interesting through PBL. Fadhil et al. (2021) used mixed methods which included a quantitative and semi-experimental research design in which students were given a summative assessment at the beginning and end of the study. The study also included a qualitative questionnaire in which the students were asked about “the components, the material taught, the classroom atmosphere, the way the teacher teaches, the advantages of the PBL model, and about the learning that has been implemented” (Fadhil et al., 2021, p. 3).

Students were broken into two groups: the experimental group (31 high-school students), and the control group (30 high-school students). Before beginning the treatment, the two groups were given a pre-assessment with the same questions that they received on a post-assessment at the end of the treatment. Of note, the post assessment questions were listed in a different order than the pre-assessment. Fadhil et al. (2021) then evaluated the data collected from the 61 participants via three different lenses: Creative Thinking Skills (CTS), learning outcomes, and student response.

“Students' CTS data analysis techniques are adjusted to indicators of creative thinking skills, namely: (a) sensitivity, (b) fluency, (c) flexibility, (d) elaboration, (e) originality” (Fadhil et al., 2021, p. 4). Based on their data, the students in the experimental group displayed a high level of skill in the areas of sensitivity, fluency, and flexibility but were still lacking in their ability to elaborate on their answers in a detailed manner. “However, overall students [in the experimental group] still lack good thinking skills, because students tend not to be able to solve problems systematically, consecutively, in detail and with detailed explanations” (Fadhil et al., 2021, p. 5). Interestingly, the students in the control group did not improve in any of the CTS criteria.

In terms of students comprehension of the material they were tested on in the pre and post assessment, the experimental group that was instructed using the PBL method improved their scores on the assessment, whereas the students in the control group who were instructed in a more traditional, teacher-centered style, showed little to no improvement on their post assessments. Fadhil et al. (2021) found “there is a very significant difference when learning with PBL towards student learning outcomes with high creative thinking categories [45], and after implementing project-based learning (PjBL) can improve student learning outcomes with a sig value of 0.013 <0.05” (p. 6). As well, the majority of student responses to qualitative surveys reflected an overall positive experience for those that participated in PBL instruction on the physics topic of waves and vibrations. Fadhil et al. (2021) concluded that their method of PBL was successful in helping students not only learn about the vibrations and wave material but also improve students overall creative thinking skills and enjoyment of learning.

Finally, in this quasi-experimental study, Pan et al. (2023) investigated the impact that both possibility-thinking (PT) and project-based learning (PBL) had on high school student’s

creativity, motivation, and content knowledge in a social studies course. For this study the authors proposed a possibility thinking and project-based learning (PT-PBL) framework that combined the elements of both the PT and PBL approach to encourage students to ask creative, authentic, and challenging questions. The sample used for this study included 140 11th-grade students from Taiwan between 15 and 16 years of age. The participants were placed into two different groups for the seven-week duration of this study. One group, the experimental group, was instructed using the PT-PBL framework and the other was taught by teachers utilizing a didactic teaching method. The course was designed by the combined efforts of university professors and history teachers and asked students to consider topics surrounding the aftermath of the Second World War. The instruments employed by Pan et al. (2023) to collect data for this study were:

> Motivated Strategies for Learning Questionnaire (MSLQ) developed by Wu and Cherng (1993), the Chinese version of Torrance Tests of Creative Thinking (Chinese TTCT) developed by Wu et al. (1998), and history midterm and end-term exams developed by a group of experienced history teachers. (p. 10)

Additionally, the authors interviewed the randomly selected student participants from the experimental group in order to develop a deeper understanding of the impact that PT-PBL had on the students' learning experience.

In this study, Pan et al. (2023), sought to understand how PT-PBL affects student's, creativity, motivation and understanding of historical knowledge. Based on the data collected over the seven-week course, the authors came to the following conclusions. Regarding creativity, the data seemed to point to the fact that the students in the experimental group improved significantly in their fluency, flexibility, and originality after participating in classes taught using

the PT-PBL method. “The rating of overall creativity (η2 =0.19), fluency (η2 =0.14) and originality (η2 =0.16) reached to large effect size, while flexibility (η2 =0.13) reached to medium effect size” (Pan et al., 2023, p. 12). Alternatively, the comparison groups scores on the same variables declined significantly when assessed after the seven week experiment. “These findings indicated that as an essential element of history learning, PT effectively engages students to think divergently, creatively and imaginatively in history project-making activities” (Pan et al., 2023, p. 14).

To understand student motivation within this study, the researchers assessed the students overall self-efficacy, understanding of task-value, and expectancy of success. Similarly to the findings surrounding creativity, the data seemed to indicate that the motivation of the experimental group improved over the course of the study, whereas the motivation of the comparison group declined. Pan et al. (2023) proposed that the PT-PBL methods' emphasis on autonomy and intrinsic motivation required students in the experimental group to put their own ideas into practice which led to a more significant positive learning outcome than the didactic teaching method was able to achieve.

Finally, upon analyzing the data surrounding the overall mastery level of historical knowledge that the participants were studying, the researchers found no significant differences between the two groups. These findings were in concurrence with a similar study conducted by Duke et al. (2021) in which the students taught using PBL methods showed no significant advantage over a comprehension group. Alternatively, several other studies (Gültekin, 2005; Halvorsen et al., 2012) found that PBL methods do have a positive correlation to students’ mastery of social studies learning outcomes. Overall, this study’s findings were significant as it

seemed to demonstrate that PBL teaching methods can positively impact the level of creativity and motivation that students have toward learning.

CHAPTER III : DISCUSSION & CONCLUSION

The primary objective of this literature review was to examine the impact that project-based learning (PBL) can have on secondary education. This study utilized the data from 30 qualitative and quantitative studies implemented in schools by educators and researchers throughout the world in order to investigate how project-based learning impacts teacher practice and student academic understanding and engagement within secondary school classrooms. This line of inquiry was addressed through three primary goals of this review: 1) The teacher's role and impact on the successful implementation of PBL, 2) To understand how to measure student academic success and overall self-efficacy for their learning, and 3) How the PBL method can enhance the overall student experience in the classroom. In this chapter, the discussion focuses on the six categories that were discovered during the research process and how they correspond to the three primary goals of this study. Ten of these studies focused on the teacher's role and impact on both their students and the PBL teaching method (Arantes do Amaral, 2021; Cole et al., 2022; De Beer, 2019; Giaffredo et al., 2022; Haatainen & Aksela, 2021; Juuti et al. 2021; Potvin et al., 2021; ; Saavedra et al. 2022; Sivia & Britton , 2021; Sun & Zhu, 2023). Six studies discussed the topic of student engagement and the strength of the relationship between students and teachers as key to allowing students to stay motivated and engaged throughout the PBL process (Al-Bahadli et al., 2023; Almulla, 2020; Carrabba & Farmer, 2018; Imbaquingo & Cárdenas, 2023; Reid-Griffin et al., 2020; Tierney et al., 2020). Six of the studies centered on authentic learning, which is a process by which teachers and students are encouraged to learn by way of dialogue and collaborative learning in order to come to a satisfactory level of understanding (Bowen & Peterson, 2019; Chen & Yang, 2019; Knezek and Christensen, 2020; Lozano et al., 2022; Makkonen et al., 2021; Miller et al., 2021). Student self-efficacy proved to

be a key component to any beneficial learning process and was notably discussed in three of the studies (Becerra-Posada et al., 2022; DeMink-Carthew & Olofson, 2020; Hanham et al., 2020) Three case studies explained the impact interdisciplinary study can have on a student's overall experience (Howard et al., 2020; Virtue & Hinnant-Crawford, 2019; Warr & West, 2020), and two studies centered on PBL's unique dimension of bringing endless opportunities for creativity into the classroom (Fadhil et al., 2021; Pan et al., 2023). It should be noted that all of the studies analyzed during this research include many elements of these six categories, so the overlap and repetition of themes throughout this portion of the thesis is intentional.

The goal of this study, primarily, was to see how PBL affects the students and teachers that use it throughout many different examples of secondary education. To continue this analysis of the different studies discussed in this research we will break down the studies into three categories: Teacher practice, both in terms of the teachers role and students engagement, academic success, highlights authentic learning and PBL's impact on student self-efficacy and finally, student experience of PBL through the lenses of interdisciplinary study and creativity.

Teacher Practice: The Teacher's Role

After the analysis of these studies was completed it became clear that the teacher's role in the implementation of PBL is vital in order for this teaching method to be effective. Although the teaching method of PBL is primarily student centered, instructors, no matter the discipline, need to act as guides for their students and lead them through the content. The review of the selected literature found that 18 of the 30 studies emphasized the teacher's role within a PBL classroom. In a qualitative study conducted by Haatainen and Aksela (2021) the 244 teachers that participated all saw PBL as a beneficial form of instruction, but they also expressed a high need for support. Teachers who took part in the study claimed the most difficult part of PBL was the

facilitation of student projects. The collected data provided evidence that most of the teachers understood what PBL was, but they struggled at times to assess and critique their students' work and final products.

This form of instruction also requires flexibility on the part of the instructor. Potvin et al. (2021) concluded that no matter how a teacher implements the PBL method, they will need to adapt and at times reinvent themselves and their lessons. “Scale through adaptation and reinvention occurred because of teachers' initiatives, which suggests that it is important to also support teachers in taking ownership of the reform and to highlight the ways teachers demonstrate that ownership” (Potvin et al., 2021, p. 11). Similarly, in a study conducted by Saavedra et al. (2022) that focused on teacher’s instructing AP students, they discovered that although PBL was an effective way of preparing students for AP exams, it was not without its need for adaptation. Saaverda et al. (2022) found that the teachers in their sample focused their instruction more on developing their students cognitive and verbal communication skills more than traditional assignments. Ultimately, using group discussions and other PBL methods seemed to be just as effective preparing students for exams as pre assessments.

Like any other method of teaching, teachers need time and opportunities to develop their proficiency. In a study conducted in 2021, Sivia and Britton investigated how teacher professional learning impacted a school-wide implementation of PBL. This study found that teachers felt empowered through the use of inquiry and inquiry-based lessons and teaching practice that is prevalent when teachers utilize PBL methods in their teaching. One of the teachers stated in his post study interview, “I am a lot more confident in the classroom…I am very present, I am in every moment, I’m not sure that was true five years ago” (p. 136). This same research also found that teachers need to have professional development opportunities on

their own terms, and in an environment that allows them to collaborate with other teachers and administrators in order to truly be successful in their practice. Collaboration is also key not only in teacher practice, but also in helping students engage with any given material.

Teacher Practice: Student Engagement

Without engagement or buy in from students, any teaching method will most likely prove ineffective. This is why it is important for instructors to find ways to help their students understand the overall importance of their content. Based on the research, it is paramount that teachers truly understand their individual student's needs in order to fully engage with them in the content. In a study conducted in 2020, researchers Reid-Griffin et al. found that teacher support was essential for student success as they provided not only academic assistance but also constructive feedback as students put together and presented their projects for each class. Without teacher buyin to the project that students create, research seems to show little evidence that PBL will be effective. One such related study was conducted by Carrabba and Farmer (2018) at a middle school where they randomly selected one teacher and their class to use PBL methods and another teacher and class to use direct instruction. At the end of the study students completed different assessments to test their level of engagement and motivation called an IMI. The researchers found that students who participated in direct instruction scored significantly lower IMI than students who received their instruction using PBL methods. The authors also found that student engagement and motivation to learn increased when they participated in PBL methods after only learning through direct instruction, but motivation continued to decrease when only learning through lecture based instruction.

PBL has also been found to improve student communication. In a qualitative case study, Al-Bahadli et al. (2023) investigated the impact that project-based learning (PBL) projects and

teaching methods had on student engagement, motivation, and academic achievement while learning online. Out of the 100 randomly selected students who participated in the study, 72% said that PBL had a positive impact on their overall communication within the course. Almulla (2020) came to similar conclusions in a study that looked at the level of engagement through five key factors: “collaborative learning (CL), disciplinary subject learning (DSL), interactive learning (IL), and authentic learning (AL), which, in turn, produced student engagement (SEL)” (p. 2). Almulla (2020) found that PBL effectively used the first four factors, CL, DSL, IL and AL which in turn enhanced SEL. In addition, Almulla (2020) found PBL also supported student and teacher collaboration. It not only assisted students in managing their studies but also created a positive learning environment for both students and teachers. Tierney et al. (2020) conducted three consecutive case studies over the course of three years with the expressed purpose of redesigning an AP course using the method PBL in order to try to improve high school students' engagement and motivation in the course. This study included a large sample size with 48 high schools and 540 students participating. At the end of this three-year study, Tierney et al. (2020) concluded that not only did PBL improve student engagement and motivation by putting students in the “driver seat” of their own learning, but also it provided a positive impact of PBL on students' academic knowledge and collaborative learning.

Academic Success: Authentic Learning

Authentic learning is a method that encourages students to investigate, discuss, and examine a topic through collaboration in order to come to a conclusion (Donovan et al., 2000). Six of the studies researched for this thesis centered around the idea of PBL’s impact on student academic success through authentic learning. In a study that centered on teaching STEM students through the PBL method, Knezek & Christensen (2020) claimed that PBL allowed students to

think more broadly about their topic through feedback provided to the authors via surveys. Additionally, the authors found that students' understanding and academic knowledge increased once PBL was implemented as compared to students who were taught using more traditional methods. In a study conducted in 2022, Lozano et al. compared student achievement via two methods of cooperative learning (CL) and PBL. The project allowed students to improve their academic knowledge of the subject (in this case a Science project about energy) as well as developing the skills of working collaboratively which is key to authentic learning. Additionally, both CL and PBL were found to be helpful in developing students' social emotional intelligence.

Academic Success: Self-efficacy

PBL is a method that can allow teachers a high level of flexibility and differentiation. This was evident in a study published in 2020 by DeMink-Carthew and Olofson. Their PBL method focused on a framework of their own design called the Hands-Joined project in which students and teachers participated in a personalized learning experience and shared the instructional power within the classroom. The researchers found that this method of teaching and learning encouraged and allowed students to advocate for themselves and their own learning. “We posit that offering opportunities for learners to make choices within the scaffolding process would further amplify student perceptions of playing an active role within the hands-joined learning experience” (DeMink-Carthew & Olofson, 2020, p.13). In a research study that focused on PBL’s impact on student’s studying English as a foreign language, Becerra-Posada et al. (2022) found that the teaching methods used in PBL not only increased student knowledge of the English language but also boosted their self confidence and love for the subject about which they were learning. They noted, “In fact, this cooperative work from peers and the teacher helped the students to reduce the social pressure they had when the project started and thus respond to the

tasks" (p. 28). Relatedly, Hanham et al. (2020) conducted a study that sought to determine the role efficacy plays in project-based learning (PBL) groups composed of either friends or acquaintances. After analyzing the data from a sample set composed of 164 students, Hanham et al. (2020) noted a strong correlation with student success academically while working with groups composed of their friends as opposed to those composed of acquaintances. The authors concluded that allowing student choice for the composition of their groups not only improved student self-efficacy but also improved overall academic performance.

Student Experience: Interdisciplinary Study

Another facet of PBL is the ability to combine several disciplines into one project, thereby enriching student learning by pulling together content from throughout their school day. One example of this came from a study conducted by Howard et al. (2020) in which an entire high school participated in a year-long, interdisciplinary project utilizing the PBL method. The "Big Idea Project" encouraged students to answer questions, "What does it mean to be human?" which entailed group projects that would be displayed in a formal exhibit at the end of that school year. The researchers conducted student surveys and conversational interviews with both teachers and students who participated in the study and concluded that "wholeschool, project-based learning resulted in meaningful experiences for high school students" (Howard et al., 2020, p. 635). In a similar study, War and West (2020) examined how interdisciplinary study and PBL can help prepare students for real world situations. In order to collect their data from the 164 participants, Warr and West utilized three separate projects over the course of two years. Their findings indicated that PBL provides students with engaging and fun opportunities to learn what collaboration may look like one day in their career field of choice. In addition, the

component of using multiple disciplines in one project, allowed students to experience the advantages and disadvantages of interdisciplinary creativity (Warr & West, 2020).

Student Experience: Creativity

The promotion of creativity within student work can often be seen within any classroom utilizing the PBL method. In all 30 of the studies used in this research, projects that allowed room for student creativity seemed to have the biggest impact on a student's experience in a class. In a study published in 2021, Fadhil et al. observed how PBL can impact high school students' creative thinking skills in the academic realm of physics. The researcher used two groups of students (an experimental and control group) to measure student content understanding and creative thinking skills through a mixed-method study of assessments and questionnaires. Students were evaluated using the following categories: (a) sensitivity, (b) fluency, (c) flexibility, (d) elaboration. Students in the experimental group improved in the areas of sensitivity, fluency, and flexibility but not in their ability to elaborate on their answers. However, students within the control group for this experiment did not improve in any of the aforementioned areas. Additionally, both groups were given a pre and post test on their academic understanding of physics, and the students who participated in the class that utilized the PBL method scored higher on their post assessment than their control group counterparts.

In a similar study conducted by Pan et al. (2023) the researchers proposed a possibility thinking and project-based learning (PT-PBL) framework that combined the elements of both the PT and PBL approach to encourage students to ask creative, authentic, and challenging questions in a Social Studies course. The study, just like Fadhil et al.'s (2021), placed the student sample into two separate groups. The data for this study was collected from 140 high school students, split into an experimental group and control group. After both groups' data was analyzed, the

authors posited that PBL teaching methods improved student's ability to think in a divergent, thoughtful and thorough manner about the different historical topics that were discussed in class. Pan et al. (2023) also concluded that PBL as a teaching method helps to increase student motivation to learn the material because the opportunity to learn through a creative method like PBL promotes autonomy and personal ownership of learning within students.

Professional Application

No matter the content, teachers, administrators and all other stakeholders within a student's life should consider the implementation of PBL teaching methods at some point during a student's education. The benefits not only on academic achievement, but also on student overall understanding of how to learn and personal self-efficacy cannot be overstated. Teachers can benefit from this particular teaching and learning method because it promotes a strong student and teacher relationship and allows students and teachers to have flexibility within their learning and teaching methods. The teacher's role is extremely important within this method of teaching because without the careful curation of materials and coaching provided by the teacher, most students would have difficulty learning the material through the use of PBL. However, PBL allows teachers to be self-reflective on their own teaching practice and make adjustments on a consistent basis in order to improve their teaching most importantly their students' learning.

Results within the United States and from around the world seem to indicate that PBL also allows students to have a greater amount of enjoyment and creativity within their own learning environments. This is important in the current educational climate where it seems that more and more secondary students struggle to find excitement or motivation in courses, whether or not they personally value the content of the course. Based on the research within this study, the PBL method is effective in a diverse amount of disciplines. Teachers have utilized PBL

within science and STEM classrooms (Bowen & Peterson, 2019; Carrabba & Farmer, 2018; Cole et al., 2022; De Beer, 2019; Fadhil et al., 2021; Haatainen & Aksela, 2021; Juuti et al., 2021; Knezek & Christensen, 2020; Lozano et al. (2022); Makkonen et al., 2021; Miller et al., 2021; Saavedra et al., 2022; Tierney et al., 2020) for students learning English as a second language (Al-Bahadli et al., 2023; Becerra-Posada et al., 2022; Imbaquingo & Cárdenas, 2023; Potvin et al., 2021; Sun & Zhu, 2023), Computer science (Arantes do Amaral, 2021; Giaffedo et al. 2022) Social Studies (DeMink-Carthew & Olofson, 2020; Pan et al., 2023; Saavedra et al., 2022) and in interdisciplinary environments (Almulla, 2020; Chen & Yang, 2019; Hanham et al. (2020); Howard et al., 2020; Reid-Griffin et al., 2020; Virtue & Hinnant-Crawford, 2019; Sivia & Britton, 2021;Warr & West, 2020).

Limitations

One of the possible limitations for any type of literature review is the fact that the author is using the findings of others, instead of their own unique and original research. Relying on the work of others, however recent, creates a limitation for the researcher in so much as they do not have the benefit of first hand experience or research to go off of.

Many of the studies that were reviewed in this thesis presented their own set of limitations. In the study conducted by Fadhil et al. (2021), some limitations observed would be the small sample size of the students evaluated and the limited diversity of the sample. This study could have been improved if it had been completed over a longer period of time so that there would have been more data in which to analyze and compare between the two groups. Similarly DeMink-Carthew and Olofson's (2020) sample size only included data from one class, with one teacher in one content area. The authors in this case proposed that it could be beneficial

to do this same study with multiple teachers and classrooms at the same time, while covering multiple different kinds of disciplines.

Potvin et al. (2021) stated that in their sample, not only did the sample include a small number of teachers, but also an above average amount of professional development and support could account for the overwhelming positive findings of their research. Additionally, my research focused mainly on secondary schools (including middle schools, high schools, colleges and universities) did not use the findings of studies conducted on elementary-age and preschool classrooms and teachers. This may have led to some key information and findings being excluded from the research, simply because the focus of the study was exclusively on secondary education.

Implications for Future Study

Project-based learning (PBL) is a diverse field of educational study. Which is why it was rather surprising to find so little research that was conducted for secondary level students, teachers, and schools. One implication for future study is the clear need for a greater amount of research and understanding of this underrepresented group within the educational research community. My hope is that I will one day be able to participate in a mixed-methods study that examines PBL and its benefits within one of my own classrooms in the hopes of adding to the available research from which others might learn and utilize in their own practice.

Through the research that was conducted, it seems that PBL has a large impact on the educational experience and learning of secondary students in most, if not all, disciplines. That said, some additional questions emerged: 1) Can PBL consistently provide students with higher academic scores than traditional learning methods? 2) What is the impact of team teaching within a classroom that utilizes PBL? 3) What impact, if any, do administrators, parents and

other stakeholders have on the effectiveness of PBL within both primary and secondary education?

Conclusion

Based on the information that has been gathered in this literature review, PBL seems to have a significant impact on both teachers and students within secondary schools across the United States and the globe. These impacts can be seen in many different areas of a student and teacher experience within a classroom and a school. Based on the research, student engagement and overall creativity seem to be benefited greatly by this method of teaching. Studies like the one conducted by Carrabba and Farmer (2018) found that student engagement and ownership over their own learning can be greatly influenced by PBL. The authors cited other studies (Ateh & Charpentier, 2014; Ferlazzo, 2015) that came to similar conclusions on this topic. That is, students who adapted to the PBL learning environment at a more rapid rate, found the increased rigor that they required and students who needed more time to become acclimated to the new type of instruction were provided the needed scaffolding from their instructor.

Both studies conducted by Fadhil et al. (2021) and Pan et al. (2023) discovered that although there was no conclusive evidence that the PBL method improved students academic ability or knowledge in comparison with more traditional methods, both studies found that students had a higher level of enjoyment when completing their work. This learning method also supports the idea that students benefit greatly when they are learning about similar topics through interdisciplinary investigation. Howard et al. 's (2020) study which centered on an entire school's participation in an interdisciplinary project led the researchers to conclude that, “wholeschool, project-based learning resulted in meaningful experiences for high school students” (p. 635). In a

similar way, War and West's (2020) study found that these forms of learning can prepare students for real world experiences and the collaborative nature of most vocational pursuits.

Little research supported the idea that there is a strong correlation between the utilization of PBL methods and observing higher academic performance from students. Although there were six studies that utilized control groups of students and teachers using more traditional methods and comparing their scores with the scores of students that were taught using PBL methods, the amount of difference between the two groups' scores were rather minimal. It seems the true strength of this learning method comes down to the value of student creativity, self-efficacy, engagement and collaboration that PBL promotes in both the students and teachers who use it.

Another key takeaway from the research presented in this study was how important the teacher role is in the effectiveness of this method. Haatainen and Aksela (2021) expressed that teachers at any level have a vital role to play in the positive impact PBL will have on their students. Potvin et al. (2021) concluded that no matter how a teacher implements the PBL method, they will need to adapt and at times reinvent themselves and their lessons. Flexibility and the need to mold lessons to fit the students that are participating in the class was a recurring theme throughout the research. This tied in with the need for collaboration amongst students but also between teachers and their pupils and between teachers and their colleagues. Sivia and Britton (2021) observed: "... it was through collaboration between teachers implementing PBL that collegial relationships, a sense of solidarity, and continual refinement of their practice occurred" (p. 135). Almulla (2020) found PBL also supports student and teacher collaboration; it not only assisted students in managing their studies but also created a positive learning

environment for both students and teachers. It also promoted authentic learning and questioning for students as they engage with more real-world problems through their PBL courses.

One final reflection that must be taken into account is that no matter the research questions, continued inquiry will be key in discovering the overall benefits of PBL. There seems to be so much promise in a learning method that provides such a strong sense of comradery amongst learners. Opportunities for flexibility where some students can take hold of their own learning and have a strong sense of autonomy and self-efficacy and other students can benefit from the collaborative experience that a group or interdisciplinary project provides.

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