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General Chemistry Students' Perceived Self-Efficacy after Completing Project-Based Service-Learning Activities

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Abstract

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by

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MS, University of Notre Dame, South Bend, IN, 1972

BA, Marymount College, Tarrytown, NY 1963

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

A New England community college reported that 60% of General Chemistry college students, who were science, technology, engineering, and mathematics (STEM) majors, did not advance in the STEM curriculum. To potentially increase student persistence in STEM curriculum, this qualitative case study project explored the self-efficacy perceptions of General Chemistry students after participating in project-based service-learning with elementary-school students. Bandura's social cognitive theory provided the conceptual framework for the study, supporting an understanding of learner self-efficacy. Research questions focused on chemistry students perceived self-efficacy after interactions with elementary-school students, teamwork, and the development of a project. Semistructured interviews with 10 participants and five reflective journals provided data that were coded and analyzed using the content analysis method. Findings revealed project-based service-learning was a viable strategy to enhance the perceived self-efficacy of college chemistry students. An increase in chemical knowledge, mentoring and teaching elementary-school students, and being part of a team developing and executing the project were frequently reported as sources for increased self-efficacy. Based on results, a 2-day professional development conference to train STEM faculty in project-based service-learning pedagogy was developed. This study affects positive social change by communicating the value of project-based service-learning in chemistry for increasing the self-efficacy of STEM majors and providing a model of professional development to improve student persistence.

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Dedication

I dedicate my dissertation to my mother, Genevieve Murphy Quast, and my father, Walter Henry Quast. My mother was the driving force in our family for education. My father gave me his love of learning, his curious approach to life, and his fascination with words. I know you would be proud of my accomplishment.

I also dedicate this work to my students. For sure, they were the impetus for me returning to school to embark on a doctoral program. I have had the privilege of being with them on their journey of advancing in their understanding of chemistry and becoming life-long learners. They are a source of joy, celebration, and motivation in my life.

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Thank you to my husband, Peter, for his unwavering support of my commitment to pursue my doctoral degree. From the beginning, he cheered me on, took care of many responsibilities around our home and family, and frequently acted as an editor of my papers and dissertation.

To my Doctoral Committee Chair, Dr. Natolyn Jones-Ferguson, thank you for your guidance, sharing your insights and wisdom, and being a constant reminder that I was on track and just needed to keep working. Also, reminding me that it is good to take breaks along the way. Dr. Jennifer Matthes, thank you for your detailed review of my work and insightful feedback. Your comments and suggestions were critical to the quality of my final manuscript. Thank you to Dr. Anita Dutrow, who was the URR for my final document, for your comments and acknowledgment of the importance of my research. Finally, to all my Walden instructors, advisers, university administrators, support personnel in the library, writing center, and research center, thank you for the outstanding instruction and support services that are available to students to be successful in our programs.

The quality of my journey was enhanced and empowered by the support of colleagues and friends. Colleagues contributed their expertise regarding the challenges students face in STEM courses and always cheered me on in the process. The interest in my doctoral studies and consistent support from friends was humbling. It was not just my success but all our accomplishment.

Finally, I thank God, my Higher Power, for the courage, willingness, and guidance to begin and complete this journey. When I was a student, my mother would say to me, "All I want you to do is your best and leave the rest to God." That was the plan I took on for my doctoral program. It worked!

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Section 1: The Problem

Introduction

Student persistence in science, technology, engineering, and mathematics (STEM) majors is a national problem. The United States is in a predicament regarding the number of native-born STEM workers. Chen (2013) studied STEM attrition over 6 years. His findings indicated that 48% of baccalaureate and 69% of associate degree students left the STEM field before they completed their degree. Mau (2016) investigated the characteristics of US STEM majors and factors that predicted their persistence finding that underrepresented minorities underrepresented minorities and women had significantly lower STEM graduate levels than White males. At the New England community college where the study took place, student persistence for STEM majors mirrored the national statistics.

The President's Council of Advisors on Science and Technology (PCAST, 2012) report forecasted 1 million STEM jobs would not be filled due to a lack of graduating STEM majors in the United States; the report notes this will happen by the year 2022. However, the STEM shortage is more complicated. Xue and Larson (2015) discovered both STEM shortages and surpluses in the job market. They found that a lack or excess of STEM workers was a heterogeneous condition that was affected by three factors: the type of STEM majors, geographic location, and employers. Depending on one or a combination of these factors, some majors had a surplus of graduates, where others had a deficiency. Also, geographic location was a factor that was pivotal for a shortage of candidates for some STEM majors. Finally, the employer was critical in whether there was a surplus or deficit of positions. Academia had a surplus of STEM professors, but the government and the private sector had openings where there were shortages.

PCAST (2012) and Chen and Soldner (2013) suggested that a place to begin to address this crisis was to increase the persistence of STEM students in institutions. PCAST (2012) theorized that if persistence of STEM majors is increased from 40% to 50%, it will result in 750,000 more STEM graduates available for employment in the marketplace nearing the goal of 1 million. Increasing student persistence and retention of STEM majors is one strategy to impact the work pool for STEM jobs. Research studies to understand student attrition and persistence in STEM majors is under extensive investigation (Arcidiacono, Aucejo, & Hotz, 2016; Chang, Kwon, Stevens, & Buonora, 2016; Foltz, Gannon, & Kirschmann, 2014; Kling & Salomone, 2015; Metevier, Seagroves, Shaw, & Hunter, 2015). At the New England community college where the study took place, student persistence for STEM majors mirrored the national statistics.

In a review of recent literature, student self-efficacy was identified as a character trait and a strong predictor of student persistence in college. Baier, Markman, and Pernice-Duca (2016) learned that students' perceived self-efficacy was one of the significant factors reported for persistence beyond the first semester in college. In one study, underachievers reported significantly lower levels of self-efficacy (Fong, & Krause, 2014). Several studies with college STEM students suggested a connection between levels of self-efficacy, persistence, and academic achievement (Aleta, 2016;

Amelink, Artis, & King Liu, 2015; Barker-Williams, 2017; Lin, 2016). In reviewing the literature on self-efficacy, some recent studies suggested an increase in students' perceived self-efficacy after participating in service-learning activities (Stewart, & Alrutz, 2014; Yang, Anderson, & Burke, 2014).

Service learning is a pedagogical strategy that provides students an opportunity to contribute to the community what they have learned in an academic environment. By engaging with others, students can practice what they have learned in the classroom and contribute to the needs of their local population. Service learning is an established approach for learning and is recommended as a useful pedagogical tool (Lieberman, 2014). A project-based service-learning (PBSL) model was used where students worked together as a team on a project to serve the community.

The study explored General Chemistry college students' perceived self-efficacy in chemistry after participating in PBSL activities. This research was significant because the study contributed to the community of knowledge regarding students' perceived self-efficacy in chemistry and service learning. The guiding research question was, how do General Chemistry college students' understand their relationship between self-reported self-efficacy in chemistry and PBSL after completing PBSL activities? The research looked at the General Chemistry college students perceived self-efficacy with the students they interacted with on the project and their team. Also, their perceived self-efficacy while working on the project was explored.

General Chemistry is a pivotal gateway course for STEM majors. Most STEM students must pass general chemistry before moving on to classes in their major field. PBSL activities are a useful pedagogical tool to increase student self-efficacy in Chemistry and support retention of STEM majors going forward.

Section 1 contains an overview of the project study. The first part of Section 1 lays out the local problem, rationale for the research, and definition of the relevant terms. The next segment discusses the significance of the study, the research questions that will guide the study. The final part of Section 1 will present a review of recent literature on the concepts investigated, the conceptual framework, and the implications of the research for the problem explored.

The Local Problem

The local problem that prompted this study was the low rate of persistence to graduation of students who declared themselves to be STEM majors at a New England community college. At the institution where the research took place, 60% of its initial STEM majors did not persist to earn associate degrees in STEM or transfer as STEM majors to a 4-year institution (New England community college statistics, June 11, 2016). This low persistence rate is a problem because a scarcity of STEM students impacts the number of STEM majors who will earn STEM baccalaureate degrees and be available for work in the local area. A local division in a regional state agency, STEM Occupation Projections (STEMOP), projected an increase in most STEM occupations in the region where this study was conducted. Finally, according to the US Department of Education's

Institute of Educational Statistics (IES, 2017), the population of all college-age learners is projected to increase by 4% from 2014 to 2025. The implication of this forecast is the number of students entering college that could be STEM majors who could graduate and contribute to the job needs in the area would not increase by a significant factor. A result of this condition could be an increased gap between the number of STEM jobs available and workers to fill the positions.

This study addressed the problem that many students at the institution who declared themselves as STEM majors (60%) did not earn an associate degree in STEM nor transfer to a 4-year institution as a STEM major. Reducing attrition of college STEM majors would provide more STEM graduates for the workforce (Chen, 2013; PCAST, 2012). Most STEM majors must pass a General Chemistry course to proceed to more advanced courses in their major. At the institution where the project was carried out, from 2004 to 2015, only 39% of students enrolled in General Chemistry who identified themselves as STEM majors completed an associate degree or qualified for transfer to a 4-year institution (Institutional statistics, June 11, 2016). Increasing the completion rate of students' taking the required General Chemistry course could impact the number of graduating STEM majors and the number of workers in the STEM fields for the local economy.

Rationale for the Problem

STEM course instructors at the institution where the study took place pointed to a population of students who questioned their ability to be successful in STEM disciplines.

Self-efficacy is a term that characterizes an individual who believes they are capable of success in general or in a domain of learning (Bandura, 1997). Various factors can contribute to a student's lack of progress in STEM courses. Chemistry instructor #1 (CI#1) shared that an inability to get homework and assignments done on time, low scores on homework and tests, difficulty in doing quantitative calculations on tests or homework problems, and critical interpretation of lab data can leave students feeling they cannot be successful in the course (personal communication, July 25, 2016). CI#1 also reported that English language learners frequently have significant challenges in expressing their ideas in English in a scientific format, as demonstrated in their performance on lab reports and exams (personal communication, July 25, 2016). These experiences can contribute to students' self-efficacy beliefs about being successful in learning the subject matter.

A lack of self-efficacy in being successful in STEM courses was manifested in diverse expressions. For some students, it was the reaction to poor performance on an exam early in the semester. Another chemistry teacher (CI#2) shared that students stopped engaging in the course and began to lose interest in being successful (CI #2,) personal communication, June 9, 2016). Math instructor #1 (MI #1) shared when students hit a roadblock in a college math course and are challenged, complain and say they can't do the problems, and then give up or drop the course (MI #1), personal communication, June 6, 2016). Also, additional students, lacking self-belief, are not aware of the effort and time needed to be effective. A physics instructor (PI #1) asserted that students lack the knowledge that if they put in the time, they can be successful in the course (PI #1, personal communication, June 9, 2016). Another manifestation of this lack of self-efficacy is a student's belief that if they did poorly in a math course, they could not succeed at a higher level (MI #2, personal communication, June 7, 2016). Finally, a faculty advisor (FA #1) disclosed that STEM majors confronting challenging classes give up their career goals in STEM and choose to enroll in a less demanding major (FA #1, personal communication, June 7, 2016). These remarks suggested a population of students, who when confronted with a challenging course, perceived themselves at risk of passing the course, in other words: ‘lacking self-efficacy’ and thus at risk of succeeding in a STEM field.

Definition of Terms

Perceived Self-efficacy: Bandura (1986) stated that self-efficacy refers to perceptions about one's capabilities to organize and implement actions necessary to attain the designated performance of skill for specific tasks.

Project-Based Service Learning: Bielefeldt, Paterson, and Swan (2009) defined project-based service-learning as a form of active learning where students work on projects that benefit a real community or client while also providing a rich learning experience.

Under-Represented Minorities: The American Council on Education (ACE) defined under-represented minorities as Black, Latina/o, American Indian, and Southeast Asian American students (ACE, 2018).

Significance of the Study

My study addressed the local problem of low student retention and persistence of STEM majors by exploring the General Chemistry college students' ' self-reported level of perceived self-efficacy in chemistry after completing PBSL activities. PBSL is a teaching strategy that combines classroom learning with a service component. This pedagogy encompasses cooperative learning, "…which [is] interdisciplinary, student-centered, collaborative, and integrated with real-world issues and practices" (Bradford, 2005, p.1).

The study provided data for analysis on students' perception of participating in PBSL activities and their concept of self-efficacy in the cognitive domain of Chemistry. PBSL is one tool instructors can utilize to provide students with experience working with chemistry knowledge and the self-efficacy associated with being successful. In other words, students not only learn but extend their skills and develop a depth of engagement and understanding through PBSL leadership efforts.

What makes this project unique at the local site is the nature of the project. General Chemistry college students interacted with participants in a real-time laboratory setting engaged in actual chemistry experiments. Schon (1987) wrote about knowledge-in-action, where the professional becomes aware of knowledge only when they are practicing their job on-the-court. Chemistry students became mindful of comprehension and understanding that previously was unavailable to them. This experience increased their sense of self-efficacy and confidence in Chemistry competency. This approach is innovative for learning Chemistry at my institution.

General Chemistry college students benefited from the findings of this project. First, students participating in the PBSL became aware of their perceived self-reported self-efficacy in chemistry and PBSL. This awareness provided insight into what type of activities empowered their perceived sense of self-efficacy in chemistry. The findings of the project suggested students' perception of self-efficacy were enhanced. A redesign of the laboratory experience in Chemistry to include more PBSL experiences is under consideration. Last, this research encouraged the implementation of PBSL in community college chemistry courses, which are taught by other instructors or offered by other institutions.

Implementation of PBSL may contribute to a higher rate of Chemistry course persistence and completion. Increased PBSL activities may help to improve the number of learners completing STEM majors and higher student employment in STEM jobs. Also, the increase in PBSL activities in General Chemistry may meet the demand of local middle-school and boys' and girls' organizations for their students to engage in authentic STEM learning experiences. This need was affirmed by the administrator (A #1; A #1, communication, August 4, 2016), the principal of the local elementary school, the science coordinator (SC #1; SC #1, communication, August 4, 2016), coordinator of Science and Social Studies at a local elementary school, and regional club director (LCD; LCD, communication, August 4, 2016). In conclusion, findings from this research may encourage the use of PBSL in chemistry as a strategy to enhance students' perceived self-efficacy in chemistry and help to meet a local need.

Research Questions

The research questions in this study addressed the local problem at the institution and explored student perceptions after participating in PBSL activities. Institutional statistics at the New England community college reflected a low completion rate of General Chemistry college students who declared as STEM majors. The purpose of this study was to explore the General Chemistry college students' self-reported level of perceived self-efficacy in chemistry after completing PBSL activities. The research questions were designed to elicit from the General Chemistry college students' participating in the exploration of their perceptions of how various interactions may have influenced their perceived self-efficacy in chemistry.

The primary qualitative research question (RQ) posed within the bounds of this proposed study is stated as being:

RQ1.0: How do General Chemistry college students' perceive their relationship between self-reported self-efficacy in chemistry and project-based service-learning after completing PBSL activities?

The research subquestions associated with the primary research question are:

RQ1.1: How will interacting with elementary school students during a PBSL project affect the General Chemistry college students' self-efficacy perceptions in chemistry?

RQ1.2: How will the General Chemistry college students' interactions with other college students on their teams during a PBSL project affect the GCCS self-efficacy perceptions in chemistry?

RQ1.3: How will engaging in the development of a PBSL project affect the General Chemistry college students' self-efficacy perceptions in chemistry?

Review of the Literature

For the rest of this section, I now address the literature information for this study. First, I discuss my conceptual framework, Bandura's theory of self-efficacy. Then, I review components of the broader problems, including service learning, and the retention and persistence of community college students.

Conceptual Framework

The purpose of this study was to explore General Chemistry college students' self-reported level of perceived self-efficacy in chemistry after completing PBSL activities. The concept that grounded the study was Bandura's theory of self-efficacy, which is rooted in his social cognitive theory. This model is referred to as social learning theory, and the investigators are called social learning researchers. Bandura began writing about self-efficacy in the late seventies (1977) but formulated the ideas in 1997 in his seminal work *Self-efficacy: The Exercise of Control* (1997). Also, this research study is informed by the work done by Schunk (1989) and Zimmerman (1989) on self-regulated learning and its relationship to self-efficacy. Educational research supports a connection and inter-relatedness between self-efficacy and self-regulated learning.

Albert Bandura's Model of Self-Efficacy

In reading the seminal works of Bandura on his self-efficacy theory of learning, the gradual evolution of the concept is clear. Initially, Bandura looked at the effect of expectation of success, transforming into a belief of being successful in the task at hand. He wrote, "An efficacy expectation is of conviction that one can successfully execute the behavior required to produce the outcomes" (Bandura, 1997, p. 193). What is hypothesized in his statement is the individual's belief in their ability to direct the appropriate behavior, which will result in the desired outcome. Bandura looked at behavior changes as the access to the successful accomplishment of the task at hand.

Bandura (1993) wrote about the role of perceived self-efficacy in cognitive development and functioning of the learner, teacher, and the institution of learning. He explained that what was necessary for a thriving learning environment was a high level of self-efficacy not only with the student but also with the teacher and the administration in the school. The student's self-efficacy will be enhanced if he is learning with a teacher who has a strong sense of self-efficacy as a teacher. Besides, the administration in the school can contribute to the success of the student by having a high level of self-efficacy as an institution to provide a positive learning environment and services to support learning. Bandura stated, "A major goal of formal education should be to equip students with the intellectual tools, self-beliefs [self-efficacy], and self-regulatory capabilities to educate themselves throughout their lifetime" (p. 136). In reviewing this statement, creating life-long learners is predicated on actions taken flowing from self-efficacy beliefs and the use of self-regulated learning actions and cognitive understanding.

A comprehensive review of self-efficacy and the four factors that support an increase in self-efficacy were found in the Encyclopedia of Human Behavior (Bandura, 1994). The essence of the theory is that an individual's belief in their ability to be successful in performing a task determines to a high degree if the individual will be successful. Bandura identified four experiences as being the primary sources of an individuals' self-efficacy: enactive mastery experience (mastery experience), vicarious experience, verbal persuasion, and physiological and affective states. In his research, he found that mastery experiences were the most significant source of enhancing an individual's self-efficacy in an area of their life. Vicarious experiences were the second most effective source of increasing self-efficacy. In this review, Bandura expounded on how perceived self-efficacy beliefs affected challenges, failures, and motivation. Individuals who perceived themselves as highly productive saw challenges as opportunities to practice what they know, and failures attributed to a lack of effort or missing skills and not a lack of intellectual ability.

Badura sees self-efficacy supporting motivation by directing goals to be established, willingness to persist in the face of obstacles, and determining how much energy should be expended. Individuals with high levels of self-efficacy come from a place where they believe they can accomplish the task at hand. Bandura emphasized the importance of having challenges so that individuals can be successful and thereby enhance self-efficacy. It is counter-productive to reduce or try to insulate the learner from challenging tasks, which will leave them less prepared to face future challenges.

Bandura's (1997) seminal book outlined and discussed the central tenets of his self-efficacy model. Beginning with the theoretical perspectives, he presented the nature and structure and four sources of self-efficacy, as well as discussing the cognitive functioning of students, teachers, and the collective school efficacy. It is comprehensive and presented a clear overview of the nature of self-efficacy and its powerful influence on the successful or unsuccessful accomplishment of tasks. Based on this model, it is vital for educators to discover sources and employ strategies to support the enhancement of students' self-efficacy. The publishing of this book opened the floodgates for research on self-efficacy.

Studying the multifaceted impact of self-efficacy beliefs on academic achievement, Bandura, Barbaranelli, Caprara, and Pastorelli (1996) analyzed the influences through which self-efficacy beliefs affected academic progress. Various scales of self-efficacy were administered to measure various self-efficacy levels. Findings indicated that self-efficacy beliefs are distinct for different cognitive domains. One may have a firm self-efficacy belief in science and a low self-efficacy belief towards writing. The researchers wrote that self-regulated skills without a high level of self-efficacy in an academic domain would be ineffective to empower the learner to persist to completion in the face of "difficulties, stressors, and competing attractions" (Bandura et al., 1996, p. 1220). In another work, the influence of affective self-efficacy beliefs on persistence was studied (Bandura, Caprara, Barbaranelli, Gerbino, & Pastorelli, 2003). Children with high perceived self-efficacy in psychosocial functioning managed situations and did not let negative experiences interfere with the task at hand. "Perceived self-efficacy plays a pivotal role is this process of self-management" (p.769).

Brady-Amoon and Fuertes (2011) explored self-efficacy, self-rated abilities, adjustment, and academic performance with undergraduate college students. Self-efficacy scales, high school GPA and a survey for student adjustment were used as data points for a nonrandom sample of students. Findings suggested that self-efficacy, self-rated abilities, and adjustment survey data were more predictive of academic performance than high school GPA or SAT scores.

Zimmerman (1989) interpreted self-regulated learning through the prism of Bandura's social cognitive model and self-efficacy. From the context of the social cognitive theory, self-regulated learning was achieved through "self-efficacy perceptions and strategy use" (p. 337). Likewise, "strategy applications provide a learner with valuable self-efficacy knowledge" (p. 336). In a review of the literature on sources of self-efficacy in schools, Usher and Pajares (2008) reported that mastery experiences were discovered to be the best foundation for enhancing self-efficacy.

Self-Efficacy and Self-Regulated Learning

In the literature review on self-efficacy, I came across several peer-reviewed articles that studied research on self-efficacy and self-regulated learning. Schunk (1991) reviewed research that explored the role of self-efficacy in the academic motivation of the learner and the interrelatedness of self-regulated learning and self-efficacy. Findings suggested the enhancement of academic motivation by students' perception of self-efficacy regarding skills, ability to be successful, and persistence. "Success on a task judged as easy will not raise self-efficacy as much as success on a difficult task" (p. 211). An article written by Zimmerman (2000) presented an argument with empirical evidence to support the impetus of self-efficacy beliefs on the learners' motivation to learn and perform self-regulated learning activities. From the research reviewed, efficacious students worked harder at the self-regulated learning tasks they use in their studies. Zimmerman referenced Bandura's attempt to measure self-efficacy in three areas: *level*, *generality*, and *strength of perceived self-efficacy*. Interviews were the most common tool used in a qualitative method to collect data for perceived self-efficacy. Finally, Zimmerman (2013), in an address, when he received the Thorndike Award, spoke of his journey of studying the social cognitive aspects of how students learn. He and Bandura believed there was a causal relationship between students' self-efficacy for self-regulated learning and academic achievement. This relationship, in turn, was "predictive of students' grade goals, as well as their final grades" (p. 139).

Self-Efficacy, Student Persistence, and Success

In an early study, Lent, Brown, and Larkin (1987) used models of self-efficacy, interest congruence, and consequence thinking, to explore each model's contribution to students' choice and persistence in science and engineering. They were interested in which of the three factors had the most significant impact on student persistence in technical and science majors. Findings from the surveys administered indicated that "self-efficacy was the most useful of the three in predicting grades and persistence in technical/scientific majors" (p. 293). Caprara et al. (2008) engaged in a longitudinal analysis of the role of perceived self-efficacy for self-regulated learning in academic persistence and achievement. The study took place over 10 years and involved 412 students transitioning from middle school to high school. Their findings indicated that self-regulated learning and self-efficacy declined as students moved through the system. Also, they learned that for this sample, perceived self-efficacy was not a function of social-economic status. The researchers hypothesized that teachers and parents could make a difference for student efficacy in self-regulated learning by working with students to "set goals, monitor their learning progress, and assess their self-efficacy for learning and self-regulation…that build up their sense of efficacy for managing their academic activities" (p. 532).

Fong and Krause (2014) carried out a mixed-methods study of underachieving college students' sources of self-efficacy. Using a self-efficacy scale, the researchers compared achievers and underachievers. Besides, reading scores and GPAs, weekly journals were used as sources for data points. Analysis of the data suggested that underachievers had significantly fewer mastery experiences and verbal persuasions than the higher achieving students. "Both qualitative and quantitative results overwhelming supported that mastery experiences are an important source of efficacy information for the underachievers" (p. 261). One of the limits of this study is the small sample of college students.

In another small mixed-methods study (8 students), resiliency, self-efficacy, and persistence of college students were studied to see if there was a relationship between the three factors and student persistence to graduation (Garza, Bain, & Kupczynski, 2014). This research had an emphasis on Hispanic students, including first-generation learners. Various scales were used to measure self-efficacy and resilience. The results of the study indicated that self-efficacy and resilience levels were independent of their parents' educational levels. Researchers suggested students who made it to graduation had learned to "adapt and adjust to college life and have developed a high sense of resiliency, self-efficacy, and persistence" (p. 11).

One of the challenges in interpreting research on persistence is the researcher's model for constancy and retention. In the case of a project study on perseverance at an urban community college, persistence was determined by whether the student enrolled in the next semester (Liao, Edlin, & Ferdenzi, 2014). Where that measure is one possible means of gauging retention, it is not necessarily a good indicator of student persistence, especially at a community college. This study explored the role of self-efficacy for self-regulated learning and motivation in student persistence. Research questions for the study include how do self-efficacy for self-regulated learning and self-efficacy for academic achievement influence persistence? Also, what was the impact of intrinsic and extrinsic motivation on student persistence? Surveys were administered to 310 students in a public community college in New York City. Analysis of the data indicated that "self-regulated learning efficacy and extrinsic motivation exerted influenced persistence/re-enrollment" (p. 606). Self-efficacy for academic achievement was not a factor for student persistence, which is measured by enrollment into the next semester.

A mixed-methods study used the National Longitudinal Survey (NLS) data to predict what efficacy factors predicted male college students' persistence to graduation (Spruill, Hirt & Mo, 2014). In addition, face-to-face interviews were conducted with the participants, as well as supplemental phone interviews. Findings suggested that parental, peer, and race can have both positive and negative influences on the persistence of the male students. Black male students held the same ambitions as their White counterparts but "being black significantly, but negatively influenced persistence to degree" (p.38). A quantitative study surveyed 1191 students in a large community college to discover psychological factors (self-efficacy, locus of control, education-employment connection, intention to return), which influenced decisions to stay in college from one semester to the next (Luke, Redekop, & Burgin, 2015). Students' declaration of an intention to return the following semester was the most predictive factor of their actual return. This study was not about persistence in an academic degree but rather if students will return the next semester. One impressive set of data indicated that students with a high degree of career-decision self-efficacy were less likely to return to community college. The researchers speculated, "these students …have gained the confidence they need to move on to the next job or educational experience or …clarified their career goals" (p. 233).

Baier, Markman, and Pernice-Duca (2016) surveyed 237 first-time college students in a large, diverse urban college. Results suggested that college self-efficacy and mentoring were the most influential factors that supported student persistence beyond the first college semester. ACT scores, GPA, and socioeconomic status were not factors in students' perseverance.

Self-Efficacy, Student Persistence, and Success in STEM

Recently published research on self-efficacy, student persistence, and success in STEM majors was scarce. In one Canadian study, the researchers examined the effect of motivation variables on science achievement for high school students enrolling in a junior college (Simon, Aulls, Dedic, Hubbard, & Hall, 2015). Questionnaires using various scales to measure motivational characteristics were administered to the participants. Findings proposed that student levels of self-efficacy were related to a higher level of *intrinsic* motivation and positive achievement. Another study at the University of California at Berkeley assessed the impact of an 8-week undergraduate research program in engineering for community college students (Amelink, Artis, & King, 2015). Bandura's four sources of self-efficacy were evaluated using summative and formative research methods. Findings suggested that contrary to general belief, vicarious experience, and social persuasion were as crucial as mastery experience in enhancing the participants' perceived self-efficacy. In a materials science class, Vogel and Human-Vogel (2016) investigated academic commitment and self-efficacy as predictors of student success in the course. A questionnaire and the final grade were the data points.

The results implied that self-efficacy and the meaningfulness of the class were predictors of success. Students' interest in the subject matter was an essential incentive for their academic commitment to be successful. The authors believed that investment in the course content was a significant predictor of the final grade. There were two articles in the literature exploring engineering students' self-efficacy. Tinkering and technical self-efficacy of engineering students in a community college were studied using a quantitative on-line tinkering and technical self-efficacy survey (Baker, Wood, Corins, & Krause, 2015). The research questions addressed what were the tinkering and technological self-efficacy of community college students, and can the level of tinkering and technical self-efficacy be identified in an introductory engineering course? Tinkering self-efficacy was rated higher than technical self-efficacy for the engineering students. The researchers concluded, "when student self-efficacy is improved, retention and graduation rates increase. Ultimately, persistence in engineering will result" (p. 563). A mixed-methods study attempted to determine sources of self-efficacy for engineering that support academic achievement for engineering majors in an International university. Aleta, asked the question, "What are the unique contribution of…engineering self-efficacy, achievement goals, and task value to the prediction of achievement and intent to persist?" (p. 54). Analysis of data suggested that "sources of self-efficacy were significantly correlated with academic achievements" (p. 53).

Another STEM discipline that researched self-efficacy related to gender and persistence was a computer technology study by Lin (2016). In this study, Lin administered a comprehensive survey to 1,073 students who were currently or once enrolled as computing science majors. He collected data on persistence, learning self-efficacy, computer self-efficacy, programming self-efficacy, and sources of self-efficacy. Lin was interested in how gender and persistence and Bandura's four sources of self-efficacy influenced self-efficacy beliefs. Mastery experiences were the most significant contributor to learning, and vicarious experiences were the main predictor of computer self-efficacy for both male and female students.

Interestingly, social persuasion had the widest persuasion for learning and programming self-efficacy. Women were more responsive to social persuasion for building self-efficacy beliefs in this study. This research is the only recent comprehensive study I found that addressed self-efficacy beliefs and persistence as it relates to gender for STEM majors.

Blaney and Stout (2017) and Barker-Williams (2017) engaged in two studies that were directly related to self-efficacy and women in STEM fields. Blaney and Stout (2017) utilized data collected during the fall of 2015 by the Computing Research Association’s Center for Evaluating the Research Pipeline (CERP) and the Building, Recruiting, and Inclusion for Diversity (BRAID) research project. This study was a large-scale (2,184 male and female responders) national survey involving 65 universities across the United States. The research examined the relationship between introductory computing course experiences, self-efficacy, and a sense of belonging for first-generation college women. First-generation women reported, "the lowest mean self-efficacy and sense of belonging compared to continuing generation women, first-generation men, and continuing generation men" (p. 72). These findings are significant in the discussion of persistence in STEM. The research suggested the insertion of best practices that supported student inclusion and a sense of belonging, which appeared to enhance student self-efficacy. Barker-Williams (2017) performed a qualitative phenomenological study with eight women who had completed degrees in computer technology. The research explored the individual mentoring experiences of these women as STEM majors. The researcher thought that social engagement would be a significant factor in student success. Students in the study did not engage in social activities. Perceived self-efficacy emerged as a more critical factor for persistence for female STEM students. "The results of the study revealed that the participants of this study did not depend on mentoring to achieve their degree; it was self-efficacy that played a vital role toward achieving the degree" (p. 112). One of the challenges for mentoring in STEM fields is that woman to woman mentoring seemed more useful to enhance self-efficacy and persistence; most STEM fields are male-dominated in the classrooms.

Self-Efficacy, Student Persistence, and Success in Chemistry

Review of scholarly journals on self-efficacy, student persistence, and success in chemistry revealed a considerable gap in the literature regarding college chemistry students' perceived self-efficacy and persistence. The research reported on four areas of self-efficacy research. One area of interest examined was an early mixed-methods study where the researchers explored the relationship between students' level of chemistry self-efficacy and enrollment or intention to register in the next chemistry course. Findings indicated that the higher student self-efficacy in chemistry, the more likely they would continue to the second year of chemistry. Dalgety and Coll (2006) wrote that students reported that previous success in chemistry enhanced their self-efficacy in chemistry. Being admitted to the second-year chemistry course early, enhanced their perception of their ability to be successful. Also, success breeds success.

As reported by Bandura (1997), the experience of success enhanced self-efficacy, which in turn supported the student in their belief that they can handle future challenges in the subject matter. About chemistry self-efficacy and gender, some participants interviewed reported: "males' concerns are focused on a specific aspect of chemistry (mathematics in chemistry, laboratory practice, etc.), whereas females have lower chemistry self-efficacy overall" (p. 111). This study was an early indication of a connection between student perceived self-efficacy in chemistry and persistence. Another area of interest in understanding a link between student perceived self-efficacy in chemistry and perseverance were the creation of valid measurements for chemistry self-efficacy. Uzuntiryaki and Aydın (2009) created a chemistry self-efficacy survey for college students to measure three areas: cognitive, psychomotor, and everyday applicability. The research question they studied was how valid their self-efficacy chemistry scale in predicting chemistry achievement was? Chemistry majors consistently scored higher on the three measures but were significantly higher in the everyday applicability measure. This study supported the notion that measured perceived chemistry self-efficacy can be used as an indication of student achievement in chemistry and persistence.

A dissertation project study (Garcia, 2010) tracked student self-efficacy in a preparatory chemistry course throughout the semester with attention to reported sources of chemistry self-efficacy in a diverse ethnic population. Garcia was interested in chemistry self-efficacy and achievement with Hispanic, Blacks, and minority women. Also, whether chemistry students' sources of self-efficacy differ from different ethnic groups or women? All four sources of self-efficacy were used by the participants to learn chemistry. All cultural groups, except Blacks, increased their chemistry self-efficacy and achievement during the semester. Blacks began with a higher chemistry self-efficacy, but that value decreased by the end of the semester.

Villafañe, Garcia, and Lewis (2014) performed a follow-up study of the previous research. This investigation was a quantitative study that focused on Hispanic and Black male students and females from underrepresented minorities. A survey was administered five times throughout the semester. Bonus points were given for attendance to students who participated in the study. Chemistry self-efficacy had a small increase for underrepresented minority female students from the beginning to the end of the semester. "Since chemistry self-efficacy is influenced by students' experiences related to the tasks presented, different groups of students would have experienced the course and its chemistry-related tasks in different ways" (p. 123). It is useful for instructors to be aware of these potential differences in students' experiences in performed tasks and offer a variety of experiences to enhance chemistry self-efficacy.

Ferrel and Barbera (2015) studied three hypotheses linked to motivation: personal interest, effort beliefs, and chemistry self-efficacy. Using existing scales for personal interest and effort beliefs and a modified range for chemistry self-efficacy, the researchers engaged in a mixed-methods study with first-year general chemistry students. Students, from laboratory sections of the course, were invited to participate. Surveys were administered to the participants. Interviews were used to clarify data on the investigation. Analysis of data suggested that chemistry majors reported higher levels of chemistry self-efficacy than non-science majors. However, the gap in chemistry self-efficacy of both majors and non-majors was not substantial by the end of the semester. This study reflected the possibility that students' perceived chemistry self-efficacy can improve during the semester and that chemistry self-efficacy was not a fixed inherent quality. An honors college capstone project explored first-year students' self-efficacy, attitudes, and intentions toward chemistry (Cook, 2013). Her research question investigated how accurate chemistry self-efficacy beliefs and attitudes indicated the students' intention to continue taking additional courses in chemistry. A quantitative research method used surveys to measure students' chemistry self-efficacy and attitude toward chemistry. The results at this university indicated that low scores on chemistry self-efficacy beliefs, attitudes toward chemistry, and a lack of intention to take future courses in chemistry. Although the results may be disappointing, the data did reflect a relationship between chemistry self-efficacy beliefs, attitudes toward chemistry, and the motivation to take future chemistry courses.

The only recent intervention study published in the literature carried out to enhance chemistry self-efficacy was a doctoral dissertation at the City University of New York (CUNY) (Kornak-Bozza, 2017). Kornak-Bozza had two objectives in their research. One goal was to develop a valid scale to measure chemistry self-efficacy changes after using a computer-based simulation of the gas laws. This scale, if found legitimate, could be used for future research. The second objective was to see if engaging in computer-based simulations in chemistry enhanced feelings of chemistry self-efficacy in the student. Students who completed the computer-based simulation of the gas law increased their self-efficacy beliefs for performing tasks on the gas laws. The significance of this study is that it looked at a topic (gas laws) in chemistry and assessed students' chemistry self-efficacy regarding that concept. My project study filled the gap of how PBSL activities, using a laboratory experience, influenced chemistry students' perceived self-efficacy.

Review of the Broader Problem

The literature reviewed for my project study covered several areas of knowledge and practice that are significant for the research. Primary and recent peer-reviewed sources on self-efficacy and student persistence were searched. Recent studies on service-learning and project-based service-learning, which are the pedagogical strategies for the project study, were investigated. The literature on the local problem of student retention and persistence in STEM majors was analyzed. The review was designed to develop a case for the condition of low persistence and retention of STEM majors both locally and nationally and how student perceived self-efficacy in academic disciplines supports student success in that subject. Finally, a review of the literature was conducted on how college STEM students' participation in PBSL activities enhanced their perceived self-efficacy and supported persistence as STEM majors.

The search was initially conducted through google scholar and worldcat.org. This approach to the literature review gave me an expansive view of peer-reviewed articles and journals on my research topic. This method allowed me to identify seminal works on the subject matter, which might be outside the 5-year search of more recent studies as well as journals that addressed the issues I was concerned about in my research. Databases predominantly used for the review of the literature were *EBSCO* and *ERIC. Science Digest* and *Sage Journals* online databases provided useful documentation for my study. Peer-reviewed journals, especially helpful in my search for relevant research, were *Community College Journal of Research and Practice, Journal of College Student Retention, Michigan Journal of Community Service Learning,* and the *Journal of College Science Teaching.*

The search terms used in the study had three main focuses: service learning, PBSL, and self-efficacy. The keywords for my search for recent peer-reviewed articles in service-learning were, *service-learning and pedagogy and higher education, and college teaching*; *service learning and value and higher education, and college teaching;*

service learning and challenges, and college teaching. For PBSL, the key terms I searched were *PBSL and science, and higher education;* and *PBSL and STEM, and higher education and college teaching.* The search terms for service learning and self-efficacy were *service learning and self-efficacy, and higher education and college teaching; and self-efficacy and service learning.* Finally, the search terms I used for self-efficacy were *self-efficacy and student persistence; self-efficacy and STEM; and persistence, and self-efficacy and chemistry.*

Service Learning

Service learning is a pedagogical strategy used in academic scholarship, where students applied the knowledge they gain in the classroom to contribute to the needs of their community. The nature of service learning is that the learning is reciprocal: the student wins by practicing what they have learned in their classes in a real-life situation, and the community is contributed to in an area of knowledge where they have a need. Academic service-learning is associated with a course and part of the curricula. The service provided is related explicitly in some way to the course content. In a seminal article Furco (1996) distinguished the nature of service learning as distinct from volunteerism, internships, and community service. Service learning is a designed pedagogy where both the contributor and the recipient receive value. Students grow in academic understanding related to their subject matter, and the recipient experiences learning or a new skill "…in such a way that ensures that both the service enhances the learning and the learning enhances the service" (p. 5). Students who participate in community service, internships, or volunteer opportunities experience value but not necessarily academic. Also, the community partner involved benefits, but may it may not be of educational significance. Lim and Bloomquist (2015) compared service learning from other forms of community service, including the types mentioned previously and the *practica* for professional training. The student can practice what they have learned by intentionally contributing to others what they have learned. Lim and Bloomquist (2015) asserted that service learning "is a form of credit-bearing experiential learning in which students participate in service in a community setting…to mutually benefit …the provider and recipient of service" (p. 203).

Service learning has its historical beginnings early in the 20th century with John Dewey's theory of education (1938). Dewey challenged the model of learning where the purpose of a school was to pass knowledge from one generation to the next. He wrote, "Learning here means [the] acquisition of what already is incorporated in books and the heads of the elders" (p. 19). Dewey proposed a new model of education where learning was acquired not by information given to the student by teachers but directly experienced by the learner in real-time. Daynes and Longo (2004) credited Jane Addams' work in the Hull house settlements as the origins of service learning practice in the United States. They asserted that the collaboration between Addams and Dewey were the beginnings of service learning. Addams's Hull house was a source of learning and service, and Dewey contributed to the theoretical concept of learning through experience. A study by Stevens (2003) traced the early roots of service learning at the turn of the 20th century to African-

American social structure and a tradition of reaching out and teaching others. College-educated individuals reached out and shared their knowledge and expertise with immigrants in the spirit of community and service. "These roots, or precursors, to service learning are part of a community service agenda using various educational procedures and social welfare initiatives to promote race, pride, and influence social change" (Stevens, 2003, p. 25).

One of the strengths of service learning is the diversity of projects and adaptability to any academic course. Dixon (2015) reviewed international service-learning projects with descriptions of possible service learning projects that had been carried out throughout the world, including the United States. Health care, physical therapy, and engineering programs accounted for 61% of all service learning curricula in the world. In a review of service learning programs in Spain, Opazo, Aramburuzabal, and Cerrillo (2016) analyzed 56 relevant documents on service service learning in Spain. This qualitative research project addressed the impact of service learning activities at the university. The influence of participation in service-learning was apparent in the improvement of the quality of the academic curriculum and the opportunity for student development. Service learning provided an occasion for diversity in delivering of the content from the traditional lecture design of the Spanish university. Also, students had opportunities to develop academically and socially via interaction with the community. Faculty professional development was enhanced by working with students in creating these projects for the community. One of the challenges in Spain was the need for more recognition of the faculty who engaged in service learning and aspiring to be tenured professors.

Service-Learning as a Pedagogical Strategy

A mixed-methods national longitudinal study was performed over four years from 1994 to 1998 on how service learning affected students (Astin, Vogelgesang, Ikeda, & Yee, 2000). The research selected a diverse sample of US colleges and universities for quantitative data. Analysis of data showed significant positive effects on all academic measures chosen by the researchers for students who had engaged in service learning activities. The qualitative part of the research included reflections by faculty and students who attended the participating institutions. Interest in the academic content of the project was significant in students who reported a positive experience of service learning. Students reflections about their service learning experience were strategic in revealing an increase in academic understanding of the subject matter. In another mixed-methods study, Davis (2013) explored the difference in cognitive outcomes for a course between students who participated in a short-termed service-learning experience and a control group who learned the same information watching an exemplar video. Reflective papers of the participants were converted to a quantitative scale for analysis. Findings suggested a positive connection between service learning and cognitive enhancement and the use of reflective journals as a reliable source for data. This study supported my project, which is a short-termed service-learning experience for the students and used reflective journals as a source of data points.

A Canadian longitudinal study gathered institutional data for assignment and final grades each semester from 2008-2013 (Brail, 2016). The research question investigated if participating in the service-learning option impacted student achievement as measured by student grades. "The data demonstrated that participation in service-learning results in statistically significant student achievement as measured by student grades" (p. 155). The study recommended getting a more accurate picture of the impact of service learning on student achievement and breaking down the data according to other subsets like gender and ethnicity.

Moely and Ilustre (2014) performed a quantitative study on the impact of service-learning course characteristics on university students' learning outcomes. A sample of 250 students was surveyed on different aspects of the service-learning experience. The findings of this study indicated students learning about the community were rated higher than academic learning. The researchers wrote that it is essential when designing service-learning experiences to be mindful of the learning outcomes desired. Also, the activity should be planned and "integrated with course content and supported by reflective activities" (p. 14). The design activities for service learning should enhance the cognitive understanding of the course subject matter. Malaysian students participated in a service-learning project where, after learning about citizenship in their class, they went to a senior living home to speak with the seniors about being a good citizen (Sivalingam, 2017). In this quasi-experimental study, students who participated in the service-learning activity scored higher on being more engaged in the subject matter and enjoyed the experience of learning through conversations with the seniors. This opportunity made learning the content more meaningful and positive experience. The use of student reflection as part of the service-learning experience is mentioned frequently in the literature. Arends (2014) wrote about reflection as access to a transformative experience in service learning, an occasion to change the individual's world view. In the context of my project study, thoughtful consideration can be an occasion for students to begin to recognize that they are performing like scientists and enhance their perceived self-efficacy in chemistry. It is in critical reflection that the learning emerges, and confidence in understanding is realized.

Two studies used interventions to assess the impact of service learning on student persistence and self-efficacy. A mixed-methods research project used a critical service-learning research intervention of preparation, action, reflection, and assessment to explore how service learning could be used to support persistence for underrepresented populations at historically Black colleges and universities (Daniels, Billingsley, Billingsley, Long, & Young, 2015). Their study questioned if participation in critical learning research impacted interest and motivation in learning. In this exploratory study, "the majority of the students… strongly agreed that critical learning research is a supportive learning strategy" (p. 184). What is revealing is that the intervention was a structured approach to service-learning activities. It included preparation for the project, action in the participation, reflection on their experience, and assessment of the learning outcomes. Data suggested that for a service-learning experience to be useful for both the student and the partner, time needs to be spent preparing and organizing for the activities.

Terry, Smith, and McQuillin (2014) were interested in evidence-based practices to assess the effectiveness of accomplishing the goals of service learning and using self-efficacy coaching strategies in support of peer-assisted learning strategies to prepare service-learning students to be effective in producing results in a literacy project with middle-school students. Findings did not indicate any significant correlation between the introduction of the self-efficacy coaches to support peer-assisted learning strategies as compared to the control group. Further research was recommended to explore this strategy because it provided a low-cost alternative for many students to participate in service-learning. In another study, Chan (2012) reviewed the literature for various ways to assess learning outcomes for service-learning projects done by engineering students. Some methods of evaluation included journals, oral presentations, and students' posters.

Service Learning and STEM Courses

Recent research on service learning in STEM courses is limited but informative. A service learning project was done with general chemistry students and at-risk high school chemistry students (Lee, 2012). Statistical data and reflections were used to assess the impact of the service learning tutoring project on final grades for underachieving students in chemistry. Without exception, all the underachieving exam grades were higher for the tutored students. Also, a positive impact on attitude about chemistry and learning chemistry was reported by the students who tutored. This project is similar to my current research because it explored the general chemistry students' perceived self-efficacy in chemistry after participating in service-learning activities. MacFall (2012) surveyed former environmental students to evaluate their experience of the value of participating in service-learning activities in their course. The majority response of those who returned the survey was that the experience had a long-term impact on the commitment to stewardship of the planet and civic engagement. Also, the experience fostered their work and communication skills with professionals in the field and "to relate ecological principles to real-world issues" (p. 26).

A service-learning project in anatomy and physiology involved community college honors students who tutored junior and senior students at a high school with a high-risk population (Ellerton, Carmona, & Tsimounis, 2016). Using reflections as the source of qualitative data, the community college students consistently reported on gains in their cognitive understanding of the subject matter and in "general education knowledge, workplace skills, and civic commitment" (p. 14). This action research project used reflections as a source of data. It showed the possible use of well-designed service-learning projects to enhance students' perceptions of their understanding of the subject. Shingledecker (2016) wrote about a community college that had a service-learning program where students found potential projects on their campus. This opportunity solved the problem of the students having to get transportation to the site to do service learning. One of the advantages of the service-learning project in my research is that the time for preparation is during chemistry lab time, and the project takes place in the chemistry lab at our institution. It is crucial at our community college to have the project take place on campus because finding extra time and transportation can be a challenge for our students.

Project-Based Service-Learning

Academic service-learning is defined as “a teaching and learning strategy that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities” (National Service-Learning Clearinghouse, 2011, p. 1). Project-based service learning fulfills all the goals listed above but has a designed architecture to have the participants working as part of a team on the activity. The added dimension of a project provides a synergistic effect on the students' service learning experience and is more impactful.

Bradford (2005) reviewed three projects of high school students in California. The purpose of the study was to evaluate three PBSL projects designed to motivate students by using technology. "Project-based service-learning emphasizes educational opportunities that are interdisciplinary, student-centered" (p. 29). The merge of service-learning and technology in a PBSL pedagogy was effective in motivating the students. Another study incorporated service-learning, technology, and a research approach to a tutoring program of university chemistry students with high school students (Saitta, Bowdon, & Geiger, 2011). Using Adobe Connect Pro, a real-time intervention was carried out at the university and in high school. The research studied how PBSL using technology impacted grades of university science majors participating in a simultaneous experience tutoring high school students. Grades on lab quizzes and a survey administered at the end of the semester were used to assess the service-learning experience of the college students. College students who participated in the service-learning project had higher lab quizzes, and 85% reported a deeper understanding of the academic material.

Tawfik, Trueman, and Lorz (2014) studied whether a PBSL project for non-science majors in a general education biology course could impact student grades in the class. The activity the students were offered was to clean up a lake in the Chicago area. Data points included grades on quizzes and exams, including pre and posttests. Evidence indicated that greater participation in PBSL activities was related to improved grades in the course for the non-science majors. Another study used service learning as an intervention to engage students in computer technology majors (Payton, Barnes, Buch, Rorrer, & Zuo, 2015). This project was an extension of the STARS Alliance project, which was working on getting students interested in working with computers using service-learning projects in the community.

Two engineering PBSL projects that seemed related to my project study were undertaken by Bielefeldt, Paterson, and Swan (2009) and Keshwani and Adams (2017). Bielefeldt, Paterson, and Swan studied measuring the impact of PBSL in terms of the influence on student-identity as engineers. They reviewed several PBSL engineering programs like EPICS and SLICE. They questioned how these programs might impact student retention as engineering majors and as a career assessment method, including the use of various scales and reflective journals. Reflection was considered key access to understanding what the participants learned from the experience. Many professors who use PBS noted that the PBSL learning context is more motivating to students than standard project-based laboratory or classroom pedagogies, and greater engagement is related to higher retention as STEM majors. The final article in the review on PBSL was an innovative project between engineering STEM majors and education majors at a college (Keshwani & Adams, 2017). Students from the college of engineering worked with education majors to develop afterschool STEM activities for local elementary school children. The qualitative study sought to "identify the shared patterns within the undergraduate engineering students' perceived learning outcomes" (p. 49). The cross-disciplinary experience appeared to affect learning in knowledge, skills, and identity as a STEM major. Also, the nature of preparing activities for the STEM club enhanced the engineering students' sense of their ability to be successful as engineers. The findings of this project are related to the purpose of my study, which explored the perceived self-efficacy of General Chemistry college students' after participating in PBSL activities with middle-school students. The gap in the literature for my research is related to college chemistry students who are doing service learning with middle-school students in the chemistry lab.

Service Learning and Self-Efficacy

There was limited information on recent projects studying service learning and its impact on the perceived self-efficacy of the participant. Stewart and Alrutz (2014) did a study on how participation in service learning affects first-year honors undergraduate students' perceptions of self-efficacy at a large 4-year research institution. This study focused on the influence between and within gender sets. A self-efficacy scale was used for pre and posttests in a quasi-experimental quantitative method. Surprisingly, results indicated that the self-efficacy of both gender groups decreased significantly from pre to posttests. The researchers suggested that perhaps the honors students entered the course with high levels of self-efficacy base on limited experiences of the subject matter. Faced with the challenges of participating in service learning, the students in the study became aware of gaps in their knowledge and lack of ability to communicate. This experience resulted in a loss of their perceived self-efficacy. These findings suggested the fluid nature of self-efficacy and factors that can impact the students' perceptions. Also, it is essential to know your students and to design activities at a level that can challenge them but still have them experience success.

Another study analyzed reflections as a pedagogical tool to support personal growth awareness and perceptions of individual and community self-efficacy (Sanders, Oss, & McGeary, 2016). The mixed-methods research design used pre and posttests for quantitative data and reflections for triangulation of the information. Structured reflections seemed to be more effective for participants to articulate their personal growth and increased perceptions of self-efficacy. Findings indicated a strong relationship between service learning and participants' personal growth and sense of self-efficacy.

Retention and Persistence of Community College Students

The challenge of student persistence in community colleges has become critical due to the declining enrollment of community college students. The American Association of Community Colleges (AACC, 2017) reported that registrations continued to decline nationally with some differences at state and local schools. One of the challenges in defining a thriving community college student is the different standards the Department of Education uses compared to the National Student Clearinghouse. National Student Clearinghouse defines student persistence for community colleges over a more extended completion period, which they argue is more consistent with the CCS' pathway to a 4-year degree. The Department of Education model was based on the traditional 4-year college or university. However, both methods of analysis predict a decrease in community college student enrollment in the future. The reality of the decline of student enrollments in community colleges makes the attention to increase student persistence and retention more significant. Also, it behooves us as educators to fulfill our professional and ethical responsibility to support our students in persisting in their educational goals.

Mertes and Jankoviak (2016) carried out a mixed-methods study and asked community college students' what factors they believed most affected retention in college. They surveyed 4,000 students, and approximately 700 students responded to the survey. As part of the questionnaire, open-ended questions were included for the students to give their perspective on retention. Quantitatively, the factors students reported most significant to lack of retention were the cost of education (64%), lack of motivation (46%), work schedule (45%), and family concerns (38%). In the qualitative analysis of the data, motivation, employee quality, cost, and administration issues were reported to be the most significant deterrent.

Luke, Redekop, and Burgin (2015) used Bean's model of college student retention, to conduct a quantitative survey to examine if there was a connection between measures of career decision self-efficacy, and intention to return to their institution for the following fall semester. They determined that students' declaration of a plan to return the next semester provided the most reliable information predicting students' retention. Career decision self-efficacy was not considered to be a factor in a decision to return the next semester. One interpretation of that data is that students with a high level of career decision self-efficacy were empowered to transfer to another institution. One weakness of this study is that the research measured retention from one semester to the next semester. There was no information if the student was successful in persisting to complete a degree and graduate.

A challenge to Tinto's model of retention based on academic and social integration was tested by Martin, Galentino, and Townsend (2014). Their research focused on students who persisted but identified as lacking social capital and not considered academically prepared. Their qualitative research approach consisted of semistructured interviews with students, faculty, and administrators. Data suggested that students compensated for their lack of preparedness and social capital with other qualities like self-motivation and support from their circle of family and friends. The researchers wrote: "students…who lacked cultural capital or academic preparedness, were able to compensate with self-direction, motivation, and development of new support systems. Social and academic integration had no effect on persistence" (p.238).

To study which factors or conditions support community college students' persistence and completion, Latz (2015) chose a qualitative method to approach using Photovoice technology. The students documented their experience of persistence with data using photos, videos, and audio. This method is useful because it is the student giving their perception of what supported them in completing their degree in an audio and visual narrative. The results for persistence suggested student support that is unique to community colleges. Academic integration was the principal factor that supported community college students' persistence. However, academic integration was a broad umbrella that included many aspects: academic validation, faculty and staff support, a positive learning environment, critical learning, and a love of learning. The community college students’ were interested only in activities that supported their goal to complete their degree. Any social integration was included as part of the academic integration and not separate.

In a goal of increased student retention and persistence to the successful completion of a degree, high-achieving low-income student retention is a focus on the review of the literature on this topic by Wilson (2016). High-achieving low-income students have challenges in persisting in community college. Most of these students leave community college after the first year. Wilson wrote that a sense of self-efficacy is one of the reasons cited in the literature that supported student persistence. The literature review also revealed that academic and social integration into the college community is a more important predictor than available financial resources as a predictor of student retention. The research of Latz (2015) suggested that community college students' perception was that academic integration and social integration, as a part of academic integration, was the guiding factor for their persistence to a degree. It might be that the academic integration model of Latz would give the student a sense of community and support their persistence. In that environment, financial support is just one challenge to handle in the pursuit of the degree.

Stuart, Rios-Aguillar, and Deil-Amen (2014) proposed a theoretical model that related student persistence in a community college with the job market and the cost-effectiveness of an education-related to available employment. This model represented another perspective in supporting student retention and persistence. The authors reformulated Tinto's model to include the consideration of students' choices affected by what employment is available and what type of a degree or credential do they need to get to be hired. Rather than just academic and social integration as outlined by Tinto, the researcher suggested the inclusion of a human capital component to be considered as part of the equation for student persistence and retention. This model does not discredit other pedagogical theories but seeks to include this outlook in the total picture for supporting the persistence of community college students.

Hutto (2017) did a quantitative correlational study on the relationship between full time and adjunct faculty and student retention in a community college. The research investigated the relationship between faculty status and student retention. Also, the investigator looked to see if there was any difference in retention between full time and part-time faculty. The findings revealed higher retention in classes taught by adjunct faculty rather than permanent instructors. They concluded that student retention was not negatively impacted by the instruction of adjunct teachers. The study suggested some reasons why the numbers may be higher for part-time faculty. However, the researcher proposed that what is happening with the instructor in the classroom may be more important than the rank of the instructor. Hutto wrote, "Understanding how faculty members can positively influence retention in the classroom is an aspect of course retention that has yet to be explored" (p.15).

Persistence and Retention of STEM Majors

Maltese, Melki, and Wiebke (2014) engaged in a comprehensive national study that explored which factors triggered students' interest in science and being a STEM major and factors that supported their persistence to a STEM baccalaureate degree. The review was a retroactive one in that they surveyed students who had already earned a degree. Also, they studied STEM faculty at the selected 2-year and 4-year institutions. Non-STEM and STEM individuals were surveyed using a link in Scientific American. Their findings were interpreted in terms of situational and individual factors for interest and persistence in STEM. Most STEM majors (65%) reported an innate interest in science before the 6th grade in school. Much of the excitement was situational in that they were exposed to science experiences from either outdoors or visits to museums and other science-type activities. The school played an essential role in their interest because of science activities in their classes. Persistence as a STEM major occurred when their attention shifted from a situational to an individual interest in STEM. Personal interest was longer-lasting, and persistence was related to not only innate curiosity but also academic grades. This study is significant because it presented a national perspective on what engaged students in STEM and what conditions supported their persistence and retention.

A longitudinal study by Chen (2015) tracked attrition of college Freshmen STEM majors among high-performing college students for six years. They were interested in the extent and reasons for student withdrawal as STEM majors. Two factors were identified as being the primary reasons. One was the challenging nature of the course material and lower academic grades in STEM courses compared to general education courses. Also, students who delayed taking classes in their major were less likely to earn their STEM degrees. These findings point to the need to engage these high-performing students in classroom experiences that enhance their chemistry self-efficacy and interest in STEM.

A large-scale, multilevel, longitudinal study of 4000 first-time students was carried out to determine if students' ability and interest in STEM could be used to predict student enrollment and persistence in STEM majors (Le, Robbins, & Westrick, 2014).

"The findings supported that both academic ability and interest were meaningful factors in student choice and persistence in STEM" (p. 26). The researchers suggested the importance of including formal and informal experiences in STEM courses to engage students and keep them interested in the subject matter. Using data from the National Education Longitudinal Study, King (2015) researched the completion rate of Physical Science and Engineering majors. The findings indicated the 57% of physical science and engineering majors persisted in completing their degree. Life science majors completed their decrees at the same rate. However, this is a higher rate of completion than social science majors but a lower rate than business and education students. One of the factors offered for a lower achievement for STEM students is the reality that science and engineering students must deal with lower GPA's in their disciplines. Generally, STEM majors had higher grades in general education courses than non-STEM majors. Chang, Kwon, Stevens, and Buonora (2016) suggested successful retention strategies implemented significant financial assistance and faculty mentorship.

Persistence and Retention of Under-Represented Minority STEM Majors

In a review of the literature, Allen-Ramdial and Campbell (2014) explored strategies that supported persistence and retention of minority and underrepresented minorities in STEM majors and STEM fields. Data indicated the most significant leak in the pipeline to completion for this cohort of students was between undergraduate and graduate school. Only 10% of PhDs' in STEM majors are awarded to underrepresented minorities even though 35% of all first-year college students declare an interest in being a

STEM major. The researchers recommended a four-prong inclusive approach to support minority students persisting as STEM majors. These suggestions included aligning institutional culture, stronger partnerships at the college to promote student persistence in STEM, maximizing, and rewarding faculty involvement in the commitment, and creating a culture of STEM success at the institution.

Another longitudinal study used the Freshman and College Senior Survey and examined the individual and institutional factors that support the persistence of underrepresented minority students in STEM (Chang, Sharkness, Hurtado, and Newman, 2014). The data indicated that Black and Latino students had a significantly lower graduation rate in STEM majors than White and Asian-American students in the study. Lack of unequal academic preparation and exposure to educational opportunities were suggested as significant reasons for attrition of STEM majors for underrepresented minorities. Qualitative research on the persistence of graduating minority students in STEM fields reported that family expectations and quality of faculty interaction were frequently reported as key to retention (Foltz, Gannon, & Kirschmann, 2014). Also, available financial assistance was stated as another factor supporting student completion of a STEM major

Arcidiacono, Aucejo, and Hotz (2016) reviewed copious data at the University of California systems for minority STEM majors. They learned that minority students with higher GPAs and SAT scores persisted at a higher rate at UC Berkeley and UCLA than minority students with lower scores. However, the students with lower scores were more successful at a lower-ranked UC university like UC Riverside or UC Santa Barbara. The researchers suggested that higher retention in STEM should be expected if there is an accurate match between academic preparation and the college or university.

In a qualitative study, 15 female STEM graduates, who had transferred from a community college, were interviewed regarding their perceptions of what factors supported their persistence as transfer community college students (Starobin, Smith, & Santos Laanan, 2016). The authors interpreted the students' community college experiences as the integration of academic and social capital that transformed into a transferring capital that enabled their successful transition to a 4-year institution. "Findings highlight positive student-faculty interactions and …classroom environments and the effect that the above factors have on female students' self-efficacy…and abilities to successfully perform in STEM majors" (p. 1040).

Interventions to Support Persistence and Retention of STEM Majors

Several studies studied the effect of interventions to support STEM majors' persistence and retention. A peer-led tutoring program for STEM majors, in gateway courses, was created for STEM majors to support persistence and retention to graduation (Kling & Salomone, 2015). The quantitative study data revealed compared to other semesters, the DFW grades were fewer, and there was an increase in A and B grades. The overall two-year STEM retention was higher compared to other years. A National Science Foundation Scholarship program, at a diverse college setting, offered financial rewards to recruit and retain physical science and mathematics majors (Chang, Kwon, Stevens, Buonora, 2016). In addition to financial assistance, the program provided structured activities, faculty mentoring, advising during critical periods, and community building through cohorts. Although the size of the group was small (44students), all the participants continued to graduate in STEM.

Finally, a report by the Institute for Scientist and Engineer Educators on a very successful 14-year mentoring program in Hawaii had an average 81% persistence completion result for underrepresented minorities, and women STEM majors (Metevier, Seagroves, Shaw, & Hunter, 2015). This program has an intense training of mentors to prepare them for working with students. "A key premise of ISEE’s philosophy is that a mentored STEM experience can be intentionally designed to be a productive, authentic contribution to the workplace, and to support factors known to influence persistence in STEM" (p. 2).

Persistence and Retention of College Chemistry Students

The literature I searched had only a few articles on research into persistence and retention for college Chemistry majors. One study by Shedlosky-Shoemaker and Fautch (2015) explored the psychological predictors for college Chemistry students' persistence in chemistry as majors. An online survey administered to incoming first-semester chemistry majors measured their perceptions of ability, performance, motivation, and identity (self-worth). Findings suggested students with self-doubt about their ability to be successful in general and as chemistry majors correlated with the students who withdrew from being chemistry majors and was related to their avoidance of failure. Chang, Kwon, Stevens, and Buonora (2016) received a National Science Foundation (NSF) grant to develop a program to support student recruitment and retention for physical science and mathematics majors. The researchers explored the impact of interventions in financial assistance, feelings of belonging, mentoring, being part of a cohort, and participating in non-research activities. The program was highly structured; it included a financial award of $6500/year for the participating students, mentoring opportunities, working with a cohort, and engaging in non-research opportunities related to their major. The students reported financial support as the most significant help for them continuing as a STEM major. Mentoring and participating in activities were cited as helpful.

Regarding College Chemistry students, two research studies explore the effect on retention and attrition using two intervention strategies. Damkaci, Braun, and Gublo (2017) used a peer-tutor model to improve undergraduate STEM retention. The format for the intervention involved having a trained peer-tutor assigned to the lab period for the class. The peer-tutor would also run a peer-led study session for the group in the lab. Institutional data on student retention was reviewed, and the students who participated in the project had higher STEM major retention as well as higher retention at the institution. The researchers suggested that student interactions with the peer-tutors were a significant factor for student retention. Comeford (2016) studied the impact on student attrition of an intervention using a team-based learning model of instruction for first-semester General Chemistry students. In this model, the student is expected to prepare for class by reading the assigned material and taking a quiz. During class time, the instructor gave a short lecture and the remainder of the time was used for working team-based learning on problems with a team assigned by the instructor. Attrition was measured in the team-based learning section and compared to students in the non- team-based learning classes. Students in the team-based learning classes had a 19% attrition rate compared to 31% for students in the non- team-based learning classes. Several reasons were hypothesized for reduced attrition and increased retention. However, as suggested by Hutto (2017), it may be that one of the critical, overlooked sources of persistence and retention of STEM students may be the role of the instructor and what is happening in the classroom.

Implications

The purpose of this project study was to obtain data on General Chemistry college students' perceived self-efficacy after participating in PBSL activities. The research was done with the hope of impacting the low rate of retention and persistence of STEM majors by increasing students' perceived self-efficacy in the cognitive domain of chemistry. Findings suggested that PBSL can be a strategy to increase students' perceived self-efficacy in the cognitive field of chemistry. This increase in perceived self-efficacy in chemistry could support participants' future success in chemistry and STEM courses. A professional development workshop was developed for STEM faculty at community colleges in the state of the New England community college. The purpose of the workshop was to educate participating faculty on the research findings from the project study, on persistence and retention, especially for community college students. Data analysis suggested the value of PBSL to enhance students' perceived self-efficacy in chemistry. A presentation of this data will be presented and used as a foundation for other STEM courses. The practicum will deliver a hands-on opportunity to design a PBSL activity for a STEM course. The design of the action is guided by the goal of persistence, retention, and Bandura's model of self-efficacy. Bandura believed self-efficacy could be accessed through a mastery experience. The data provided the underpinning for a PBSL experience that is strategically designed to produce an outcome of enhanced students' perceived self-efficacy in a STEM course. This project will give participants the confidence to include PBSL as part of their curriculum offerings and support student retention and persistence in STEM fields.

Summary

Section 1 reviewed the local problem that institutional statistics at New England community college reflected low completion rates of General Chemistry college students who declare as STEM majors. It was noted that the condition of low retention is not only a local problem. A review of the literature indicated that nationally half of the students who declared as STEM majors in their freshman year of college do not earn a degree as a STEM major. Institutional data from the New England community college supported the problem; personal conversations with individuals at the institution concurred that student persistence in STEM courses was a problem in their classes or advising students. The purpose of the study was to explore General Chemistry college students' perceptions of self-efficacy after participating in project-based service-learning activities. The argument for the significance of the study of the problem of student persistence in STEM majors was presented as well as how studying this problem can support retention in STEM majors at the local level. Research questions were developed in alignment with the context of the local problem and purpose of the project study. The literature was reviewed both for the conceptual framework of self-efficacy and models of persistence and retention. Peer-reviewed articles were gathered for recent studies on self-efficacy, service learning, and retention. The first part of section 2 will discuss the methodology used in the project study, the sample population, data collection, data analysis, and limitations of the study. The second part of Section 2 will relate to the research and will include results. Section 3 will be The Project created from the findings of the research, and Section 4 will include the reflections on the research and the conclusions of the capstone project.

Section 2: The Methodology

Qualitative Research Design and Approach

This study explored General Chemistry college students' lack of perceived self-efficacy manifested in a general chemistry course for engineering and science majors. Studies suggested a connection between students' persistence in college and the level of their perceived self-efficacy (Garza, Bain, & Kupczynski, 2014). Findings asserted that high levels of perceived self-efficacy support student persistence as STEM majors (Amelink, Artis, & King Liu, 2015; Barker-Williams, 2017; Blaney & Stout, 2017). Also, the pedagogical method of service-learning showed promise of enhancing student self-efficacy in the cognitive domain of the subject matter (Starobin, Chen, Kollasch, Baul, & Laanan, 2014). PBSL is an approach to learning, where the participants perform their activities of service to the community as part of a team. Studies suggested that PBSL may be access to enhanced perceived self-efficacy for a student. The purpose of the study was to explore the relationship between General Chemistry college students' self-reported level of perceived self-efficacy in chemistry after completing PBSL activities**.** The significance of this study is that it provided data for analysis on students' awareness of how participating in PBSL activities may influence their perceived concept of self-efficacy as it relates to the cognitive domain of chemistry.

Qualitative Research Design

Yin (2014) asserted that research methods should be in alignment with the research questions posed. Quantitative methods using experimentation are employed when there is a hypothesis of how and why something happens. This method involves a control that allows for comparison. Surveys are used when the research questions are broad, and the investigation attempts to analyze multiple answers. Archival analysis and historical methods are used when the researcher is interested in the analysis of past occurrences. Quantitative method designs include a null hypothesis to be supported or rejected by the evidence of the research. This study is exploratory and seeking to discover emerging themes; therefore, it is not appropriate to use a quantitative method for analysis.

The purpose and research questions for this study suggested a qualitative method design is an appropriate approach for collecting data. This method is preferred when the researcher is interested in gathering rich descriptive data on the topic, in the environment of the participants, viewing the situation from the participants' perspective, and valuing the perspective of the researcher as an integral part of the data collected (Hatch, 2002). Qualitative research is informed by philosophical assumptions and guided by an interpretive framework (Creswell & Poth, 2018). Philosophical assumptions for the qualitative researcher include reality, as seen through multiple views (*ontological*). Direct quotes from the participants and the experiences the researcher catalogs in the field are recognized as evidence for the study (*epistemological*). Biases and values are an innate part of qualitative research. Researchers must present and discuss their preferences and take responsibility for how these influences might affect their interpretation of the data. (*axiological*). Finally, the *methodological* assumption for a qualitative inquiry is inductive. Data is gathered and interpreted within its context for emerging themes and generalizations.

The issue explored in this study was General Chemistry college students' perceived self-efficacy after participating in PBSL activities. The nature of the research lent more to a descriptive set of data that characterized qualitative inquiries. Social constructivism was the interpretive framework for the study because it allowed me to consider how multiple perspectives and experiences created different views of reality. Creswell and Poth (2018) wrote, "Multiple realities are constructed through our lived experiences and interactions with others" (p. 35). Emerging themes were identified through consensus by interpreting multiple sources of data like interviews, observations, and documents.

Case Study Method

The qualitative case study was the best approach for gathering data for this study. Although other research approaches collect information, the context for a specific plan creates the prism that will guide the type of data collection and interpretation in the study. In qualitative methods research, a case study is defined as a situation or interest of study (Stake, 1995) or a method of qualitative analysis (Yin, 2015). In this investigation, Yin's model of the case study was used. According to Yin (2015), "A case study allows investigators to focus on the 'case' and retain a holistic and real-world perspective" (p. 4). This approach was chosen because the nature of the study lends to an in-depth study of a sample population. In this study, a bounded case, I was concerned about the case, not the process (Stake, 1995). This study was an intrinsic case study because the focus of the research is a specific situation of General Chemistry college students and their perceived self-efficacy after participating in PBSL activities. In the study, I was attentive to one class and one event in that class. Stake (1992) wrote a case that was intrinsic when "We are interested in it, not because by studying it we learn about other cases, …but because we need to learn about that particular case. We have an intrinsic interest in the case…" (p. 3). My curiosity in the case was learning about General Chemistry college students' self-reported perceived self-efficacy after participating in PBSL activities. For this study, using the case study was a superior approach to other forms of qualitative inquiries.

Phenomenological methods are interested in the everyday experiences of an individual (Lodico, Spaulding, & Voegtle, 2010). This approach would not collect the data needed to address the research questions for the study. Ethnological approaches are concerned with the culture of the participants in the research (Lodico, Spaulding, & Voegtle, 2010). The cultural experience of the participants was not a focus of the current study. My attention was from the students' perceived self-efficacy after participating in PBSL activities. Likewise, historical research does not provide the data necessary for the questions being posed in the project study. Researchers involved in this type of investigation, "…portray the lives of people in a particular setting or context through storytelling" (Lodico, Spaulding, & Voegtle, 2010, p. 38). Finally, grounded theory is a qualitative method that seeks to use data from the study to create a new model in the view of the participants (Creswell & Poth, 2018). The purpose of the current study was to collect data on General Chemistry college students' self-reported self-efficacy after participating in PBSL activities. The goal of the study was not to use the information gathered to create a new theory but to discover emerging themes regarding General Chemistry college students' perceived self-efficacy after participating in PBSL activities.

A qualitative case study was the research design for this project. A qualitative case study was an appropriate methodology to support this research because it permitted me to collect data "…rich in a description of people, places, and conversations, which is not easily handled by statistical procedures" (Bogden & Biklen, 2007, p. 2). As described by Stake (2005), "the case is undertaken because, first and last, one wants a better understanding of this particular case" (p. 445). This type of investigation allowed me to focus attention on how this intervention is perceived by the participants who are aligned with the purpose and proposed research questions for the research.

Participants

The criteria for selecting participants was a nonprobability (purposive) sample. While qualitative methodologists use the terms purposeful or purposive sampling, quantitative methodologists are more likely to label these strategies *nonprobability sampling*, making explicit the contrast to probability sampling (Patton, 2015). This method of selection is preferred for qualitative studies because this type of research is not seeking to generalize. "Case study research is not sampling research. We do not study a case primarily to understand other cases. Our first obligation is to understand this one case" (Stake, 1992, p. 4). Students selected to participate in the study were from a pool of possible candidates. The latter had completed the first or second semester of the General Chemistry course sequence and declared STEM majors. Selected participants who participated in the PBSL activities were from different classes of General Chemistry. A *typical* case type of sample was created for the study (Creswell & Poth, 2018). This method of selection provided participants who represented the population. The size of the sample was 10 students, which is the right size for an in-depth inquiry with each individual.

Procedure for Gaining Access to Participants

After approval from the New England community college's Institutional Review Board and submission of final grades, all students in the class for the study were sent an email and invited to participate in the research project (Appendix A). Students were informed that participating in the study might give them insight into factors that will support their success and persistence as STEM majors. The sample for the study was identified on a first-come, first-serve basis, following the criteria established. This process of selection of participants strived to attain a typical case sampling, reflecting the population of the cohort of students in the class. Students were informed that their participation was completely voluntary and had no academic connection to their previous General Chemistry course.

Researcher-Participant Relationship

The students who participated in the project study were former enrollees from my General Chemistry course. Potential participants were not informed about the research project during the class. The chemistry students viewed the PBSL task as one of the specific activities of the chemistry course. After the course completed and final grades were submitted to the college (approximately January 2, 2019), I sent out to all the students in the chemistry course, information about the project and an invitation to participate. Chemistry students interested in participating in the project sent emails or texts indicating their interest in participating. At the initial request, I received communication from four students who showed interest in participating in the study and not currently in my course. The invitation was then opened to former students in General Chemistry courses from previous classes. I was able to finalize a sample of 10 former students for the study. The breakdown of the sample was that seven individuals were enrolled in the fall 2018 or spring 2019 general chemistry courses. Three participants took part in the project two years ago, had graduated from the community college, and pursuing additional academic STEM-related degrees.

Ethical Protection of Participants

The procedures followed in this research study permitted the participants to share their experience freely participating in the PBSL activities. After Institutional Review Board approval, an email was sent to students in the targeted General Chemistry course, informing them of the nature of the project study with an invitation to participate (Appendix A). Students were told that participation in the project was voluntary and had no impact on their grade, whether they choose to participate in the study. Instructions were given on how to respond if they were interested in participating or had any questions. Using the established criteria, ten students were selected as potential participants and emailed an electronic copy of the informed consent. The email was sent to their personal email to ensure anonymity and separateness from the college. The electronic form of the informed consent allowed participants to review the nature of the study ahead of sitting for the interview (Appendix B). Each potential participant was given the opportunity to ask questions before written consent was obtained. I set up the interview times, and the students chose the location from two options offered. Before all interviews, the participants read and signed the informed consent forms and filled out a form with a request for demographic information (Appendix C). Participants who submitted their reflective journals signed and dated the journals to permit the use of the data for analysis for the study. All names of participants were kept confidential and pseudo appellations were used throughout the study. Participants were informed that all personal information and artifacts obtained in the study were secured in a locked file cabinet in my home and that I will be the only one viewing the information.

Addressing Potential Bias in the Project

The case study design, which included the researcher as part of the process, can lead to interpretations based on the researchers' assumptions and beliefs rather than what emerges from the data. In this project study, I was the researcher, and the participants were former students. Bias is one of the inherent pitfalls in case study research. The potential for bias was exacerbated in this situation because of my role in the study.

Yin (2015) wrote about the necessity of avoiding bias in conducting interviews and collecting data. He suggested one way to prevent bias is "by being sensitive to contrary evidence, also to know how to conduct research ethically" (p. 73). Yin proposed one useful action to test bias was while still collecting data, present initial findings to a few colleagues for their critical analysis and alternative interpretations of the data. If rebuttals can produce documentable evidence, then bias is more likely reduced.

Also, a *transcript review* of the summary of the transcripts of interviews was helpful in corroborating the participants' views and provided a balanced perspective on the research (Lodico, Spaulding, & Voegtle, 2010). One of the data points in this study were reflections I wrote before, during, and throughout the PBSL project. This information from my journal allowed me to see bias and was a tool to triangulate my perspectives with the participants in the study. It is the responsibility of any researcher to conduct their investigations with the highest ethical standards, which includes an obligation to scholarship, being honest about all aspects of the study, avoiding deception, and accepting full responsibility for one's research (Yin, 2015).

Data Collection

The purpose of the project study was to explore General Chemistry college students' perceived self-efficacy after completing PBSL activities. Data was gathered on General Chemistry college student’s perceived self-efficacy for specific aspects of PBSL activities in chemistry. Data points were collected from responses to interview questions from participating students (Appendix D) and prompts for writing in their reflective journals (Appendix E). I took notes during the meeting and wrote up a summary of my observations immediately after the session. The interviews were taped and transcribed by a professional dictation company. The transcriptions returned with a simultaneous translation with voice recording. I listened to the audio recording and reviewed the transcript to make any additions or corrections for accuracy. I made summary statements of the interview questions and sent the document to each of the participants for a member check. A peer completed a review of the transcription of the interview and the summary statements to evaluate my findings and offer suggestions and insights.

Reflective journals were a part of the PBSL activity and were kept by all students in the class as part of the requirements. The reflections were written during class time. Journals were not graded but were used by the students to gain insight into their experiences before, during, and after the completion of the project. Students who were selected to participate in the project were asked, as part of the Informed Consent, to bring their journals to the interview to be included as part of the data. I audiotaped the reflective journals and had them transcribed by the same dictation company. I made summary statements for each set of reflective-journal questions for each participant.

Also, I used *transcription review* to validate participant information gleaned in the interviews and reflective journals. This research explored General Chemistry college students' perceptions of self-efficacy after participating in PBSL activities. Interviews are considered a significant source of data for understanding what is going on in someone's mind and providing an insight into their worldview (Hatch, 2002; Patton, 2015). Tapes were kept in the iCloud on my personal computer system, which is protected by a password. Transcribed tapes, summary notes of the interviews, and participants' journals were kept in a locked file in my home. The data collection tools that addressed each research question are identified in Table I.

Table 1

Data Collection Tools That Addressed Research Question

Research Question (RQ)	Data Source
RQ 1.0 How do college students perceive their relationship between self-reported self-in chemistry and project-service-learning (PBSL)?	College student weekly reflective journals, of participating college students. Reflections efficacy written before, during, and throughout the based PBSL project. One-to-one interviews of the participants in the study. Transcription checking of participants' data.
RQ 1.1 How did interacting with elementary-school students, during a PBSL project affect the college students' self-efficacy perceptions in chemistry.	College student weekly reflective journals, of participating college students. Reflections are written before, during, and throughout the PBSL project. One-to-one interviews of the participants in the study. Transcription checking of participants' data.
RQ 1.2 How did college chemistry students' interacting with other college students on their team, during a PBSL project, affect the college students' self-efficacy perceptions in chemistry?	College student weekly reflective journals by participating, college students. Reflections are written before, during, and throughout the PBSL project. One-to-one interviews of the participants in the study. Transcription checking of participants' data.
RQ 1.3 How did engaging in the development of a a PBSL project affect the college students self-efficacy perceptions in chemistry?	College student weekly reflective journals, of participating college students. Reflections are written before, during, and throughout the PBSL project. One-to-one interviews of the participants in the study. Transcription checking of participants' data.

Data Analysis

Data was consolidated, reduced, and emerging themes identified using the *content analysis* method. Patton (2015) wrote, "Qualitative analysis transforms data into findings. No formula exists for that transformation…the final destination remains unique for each inquirer, known only when—and if—arrived at" (p.521). The content analysis strategy for data examination is a quantitative approach for organizing the many information points generated in qualitative inquiries (Maier, 2018). Maier identified the qualities of *objectivity*, *systematic*, and *generality* as significant criteria to be met when using the content analysis approach. In analyzing the data, I used consistent codes and procedures to reduce bias and increase objectivity. This approach to coding and interpreting data was systematic based on a set of guidelines that determined which information was included in the data set. Finally, the content analysis must have a quality of generality, which was relevant to the research questions explored.

Coding units were created as a guide for the selection of text (data points) to build a description related to GCCS' perception of self-efficacy in chemistry after participating in PBSL activities. I developed codes as particular words and phrases began to repeat themselves in the interviews. I created these codes into themes and examined how they connected to the research questions. In some cases, information from participants varied. An example of this was which aspect of the project enhanced their self-confidence in chemistry. Some of the participants found participation on the team as significant in increasing their confidence in the domain of chemistry, while others found working in a group challenging and disheartening. In examples like this, I discussed both points of view. It is vital to present and discuss all perspectives to evaluate the contribution of the project. I remained open to all viewpoints shared during the interviews. Maier (2018) asserted that the quality of the coding units should be exhaustive, covering all possibilities.

Limitations of the Study

The major limitation of this study was the very narrow focus for the research and the size of the sample population. This study explored General Chemistry college students' perceptions of self-efficacy after participating in PBSL activities. The study looked from the cognitive domain of chemistry and after one PBSL experience. However, research findings indicate the short-termed service-learning experiences can impact student self-efficacy (Davis, 2013). Another limitation is that this project only addressed students in a general chemistry course. Although this course is a gateway course for STEM majors, you cannot generalize the results for all STEM courses.

Another limitation of the study was that the population under investigation were my former students. Case-study design has an inherent weakness of bias given the nature of the role of the researcher in the research. In this project study, bias is compounded because the researcher and participant have an instructor-student relationship. To reduce bias being a limitation to the project, I implemented specific strategies for my research. First, according to Walden’s requirements for a project study at one’s institution, the participants must be former students, so I did not have a current student-instructor relationship. When I formulated the email invitations, I made it specific in the communication that participation was voluntary and would not in any way affect their grades (Appendix A). Another strategy I used was to share with each potential participant about the purpose of the project and what my research questions were for the project. I disclosed to them that I just needed to learn about PBSL and its potential to be an effective strategy to help students be successful in STEM majors. I was looking for data, and the best way they could help the research was, to be honest in the answers to the interview questions. Finally, using the same semistructured interview and reflective-journal questions for each participant removed bias that might have happened if the interview questions were open-ended.

Finally, the design of the project study was exploratory, which of its nature limits the ability to form generalizations. However, exploratory research projects are essential and frequently are the seeds for more substantial inquiries.

Data Analysis Results

Data points generated for the project study were from 10 former students who participated in the project-based service-learning activities in chemistry with elementary school students. The source of data was one-on-one interviews with each participant using semistructured interview questions (Appendix D). Data were also gathered using reflective-journal questions from five participants (Appendix E). Meetings took place in a private conference room agreed to by the students and approved by the Institutional Review Board officer at the institution. The discussions were audiotaped using two recording devices. Also, information was gathered from reflective journals provided by five participants. Five participants did not have journals available for analysis. One participant thought his wife had thrown it out, another individual could not find it in her home, and three participants had participated in the activities two years ago and did not have them. Students gave signed permission to use their reflective journals for the research analysis.

The audiotaped interviews were submitted to a professional dictation company for transcription. The transcriptions returned with a simultaneous translation with voice recording. I listened to the audio recording and reviewed the transcript to make any additions or corrections. Summary statements of the interview questions were sent to each of the participants at the email address they requested to review the document. I asked them to reflect on whether the summary statements reflected their experience participating in the project-based service-learning experience. Two of the participants replied they were satisfied with their interview responses and the accuracy of the summary statements. None of the other participants responded with requests for corrections or additions. I voiced-recorded the information in the reflective journals from the five participants. These audio files were sent for transcription to the same service as the interviews. Again, I compared for accuracy the audio file, transcript, and reflective journal. Data was consolidated, reduced, and themes identified using the *content analysis* method. The content analysis strategy for data examination is a quantitative approach for organizing the many information points generated in qualitative inquiries (Maier, 2018).

Maier identified the qualities of *objectivity*, *systematic*, and *generality* as significant criteria to be met when using the content analysis approach. Hatch (2002) asserted that the analysis of data is a search for meaning derived by interrogating and questioning the data to reveal patterns and themes. This approach is aligned with the qualities of objectivity, systematic, and generality that Maier identifies in his discussion of content analysis. The researcher is an investigator who asks many questions of the data, inclusive of all information, open to the unexpected, and not attached to a particular outcome (Hatch,2002). The researcher strives to understand the truth from the participant's perspective.

For coding purposes, the reviewed and edited transcript of the participant interview was converted into a line-number stanza format. The documents were identified with a number in order of the date of the one-on-one interview. Hatch (2002) recommended focusing on data relevant to the research questions and not be distracted by extraneous information. I reviewed and highlighted each transcript, identifying the interview question and the participant's response to the question. I then followed a method of *typological analysis* recommended by Hatch (2002) but formulated by Le Compte and Preissle (1993). They suggested that categories for the organization be framed based on the purpose and research questions formulated for the inquiry. Hatch's steps for the basic typological model is outlined in *Figure 1* (Hatch, 2002, p.153). During the process of working with the transcriptions, a category for personal insight and awareness was created.

I went through each interview transcript and highlighted, with color-coding, stanzas I thought related to the predetermined categories. The next step in the process was to create a table for each participant correlating the interview question with quotations of responses related to the interview question. I then inserted on the table, in a separate column, which of the initial categories the statement referred. This process gave me a quick visual as to which categories predominated for each of the participants. A summary statement was created for each informant based on responses to each interview question (Hatch, 2002). I authenticated the summary statements by indicating the stanzas on the transcription document that were used to create the account. “The key is to have solid summaries that can easily be located, identified, and manipulated (Hatch, 2002, p.155).

Figure 1

Steps in Typological Analysis

1. Identify the typologies to be analyzed
2. Read the data, marking entries related to your typologies
3. Read entries by typology, recording the main ideas in entries on a summary sheet
4. Look for patterns, relationships, themes within typologies
5. Read data coding entries according to patterns identified and keeping a record of what entries go with which elements of your patterns
6. Decide if your patterns are supported by the data, and search the data for nonexamples of your patterns
7. Look for relationships among the patterns identified
8. Write your patterns as one-sentence generalizations

The next step was to cross-reference data from the interviews. The first table I created aggregated the informants' responses for each interview question. Initial categories were identified for each participant statement, where appropriate. The next step in the process was to aggregate the statements of all participants for each question. This format provided an excellent visual presentation of how the accounts of all the participants compared for each question. As part of this process, I included a code for each participant's statement with only one of the research questions (RQ1.0: knowledge of chemistry; RQ1.1: elementary school students; RQ1.2: team; RQ1.3: developing the project). My goal for making cross-referencing statements with the research questions was to determine if there were enough statements to address all the research questions. Finally, I took the table where I had identified the four categories associated with the RQs and consolidated all the reports into one of the four lists. Also, I coded each account on the list with the corresponding student identification number.

There were five journals received from participants. I voiced-recorded the writings in the journal and transcribed the five audio recordings into a word document like the interviews. A table created the responses of the participants in their reflective journals. Another table generated the combined reflection responses.

Research Findings

This study explored General Chemistry college students' lack of perceived self-efficacy manifested in a general chemistry course for engineering and science majors. Studies suggested a connection between students' persistence in college and the level of their perceived self-efficacy (Garza, Bain, & Kupczynski, 2014). Findings asserted that high levels of perceived self-efficacy support student persistence as STEM majors (Amelink, Artis, & King Liu, 2015; Barker-Williams, 2017; Blaney & Stone, 2017). The pedagogical method of service-learning has shown promise of enhancing student self-efficacy in the cognitive domain of the subject matter (Starobin, Chen, Kollasch, Baul, & Laanan, 2014). PBSL is an approach to learning, where the participants perform their activities of service to the community as part of a team. Several studies have shown a positive connection between PBSL, enhanced student engagement, and STEM identity (Bielefeldt, Paterson, & Swan, 2009; Payton, Barnes, Buch, Rorrer, & Zuo, 2015; Keshwani & Adams, 2017). The findings of the project are related to the purpose of my study, which is to explore the perceived self-efficacy of General Chemistry college students ' after participating in PBSL activities with elementary-school students. The gap in the literature is related to college chemistry students who are doing PBSL with students in the chemistry lab. The purpose of the study is to explore the relationship between General Chemistry college students' self-reported level of perceived self-efficacy in chemistry after completing PBSL activities**.**

Research Findings Related to Research Questions

This study was designed to gather data to explore General Chemistry college students' self-reported self-efficacy after completing PBSL activities. The research questions were intended to elicit from the General Chemistry college students participating in the research, their perceptions of how various interactions may have influenced their self-efficacy in chemistry. I used Bandura's (1986) definition of perceived self-efficacy (self-belief), which he stated refers to perceptions about one's capabilities to organize and implement actions necessary to attain designated performance of skill for specific tasks. Bandura identified four experiences as being the primary sources of an individuals' self-efficacy: enactive mastery experience (mastery experience), vicarious experience, verbal persuasion, and physiological and affective states (Bandura, 1994). In his research, he found that mastery experiences were the most significant source of enhancing an individual's self-efficacy in an area of his or her life. Besides, he emphasized the importance of challenges so that individuals can be successful and enhance their self-efficacy. This study explored if PBSL activities performed by the General Chemistry college students were perceived by them as enhancing their self-efficacy in chemistry.

Self-efficacy was a concept not generally familiar to the college chemistry student. The interview questions I asked in this study used the term *confidence in chemistry* to parallel the model of perceived chemistry self-efficacy. My rationale for this terminology was that if students saw an increase in their confidence understanding and being able to be successful in chemistry, the experience can be related as an increase in their perception of being able to do what it takes to be successful in chemistry. I asserted that it is in alignment with the concept of self-efficacy in the domain of chemistry. The overall question in this research was, can this teaching strategy be identified as a possible enactive mastery experience according to Bandura’s criteria that could enhance the General Chemistry college students’ perception of self-efficacy in the domain of chemistry?

Using Hatch’s (2002) typological template for organizing data, based on the research questions, I created four categories to consolidate participant responses: RQ1.0: knowledge of chemistry; RQ1.1: interacting with elementary school students; RQ1.2: team; RQ1.3: developing the project. The following section presents the findings based on these criteria.

Knowledge of Chemistry. The guiding RQ for this study was, how do General Chemistry college students’ perceive their relationship between self-reported self-efficacy in chemistry and project-based service-learning? In collating data for analysis for this RQ, I looked for self-reported comments to interview questions by the participants that indicated an increase of chemical knowledge both in content and lab mastery. Three themes emerged in responses to the 11 interview questions. They were preparing the material to be taught; designing and preparing the experiment the students would be performing, and the experience of the General Chemistry college students' working with the kids during the activity.

Preparing the content. Eight of the 10 participants in the sample reported an increase in chemical knowledge out of participating in the PBSL activities. Chemical knowledge ranged from a "slightly better understanding of the material from Participant 1 to Participant 9, who reflected, "I have more understanding of chemistry and it changed me a lot."

Participant 5 reported an increase in chemical knowledge and more confidence in chemistry from preparation for the project.

> I was more confident [in chemistry] because I had to learn a lot of words to be able to explain it to someone else. Definitely more confident and enjoyed it more because I got to do the experiments and understand them.

Participant 2 talked about how the format his team designed for the experiment, forced him to learn the concepts.

> Our activity used a Q &A format. It was hard to come up with the questions and the correct answers. That [process] helped me know more about the different types of tasks for chemistry students to learn.

Participant 3 shared how the PBSL project supported her original knowledge of chemistry and studying.

> Participating in the service-learning project did support my original knowledge of chemistry work I was doing. It's a good way to study…to better grasp the information and retain…a good learning support.

Participant 7, who is currently a STEM major at the university, spoke about how participating in the project gave her more knowledge, especially in her future career.

> It gave me more knowledge. Doing different experiments and helping kids. I think that helped me if I wanted to do research in chemistry, I would know how to put the steps together to do the research. After a while, I could do the experiments without checking the procedure. That supported me by giving me knowledge.

Participant 10 also spoke about the impact of doing the project on his future STEM career.

> More practice for what we have [to do] in the future…preparing and using chemicals. In service-learning, we had to prepare all the materials…label everything and do precise measurements, so when the kids came, we could show them without messing up.

Teaching the kids. Six of the 10 participants reported an increase in chemical knowledge through working with and interacting with the middle-school students.

Several shared how teaching the kids helped them learn and understand the concepts. In some cases, the responses were worded similarly.

Participant 2 said, “I was able to learn more about chemistry through the kids. I feel I want to learn more chemistry now and have more impact for me in the future.”

“I had more of a grasp of the subject because you had to understand it more to teach it to little kids,” said Participant 8.

Participant 9 shared, “My understanding was better because you had to understand it more to teach it to little kids.”

Participant 7 elaborated on the overall impact of working with the kids.

> It gave me more knowledge, doing different experiments and helping kids. I think that helped me. If I wanted to do research in chemistry, I would know how to put the steps together to do the research.

Designing and p**reparing the experiment.** Last, five of the 10 participants reported an increase in their chemical knowledge was derived from doing the experiments with the students. The knowledge acquired was a better understanding of the chemical principles involved in the experiment. Also, they learned how to execute the experiment more accurately. Participant 7 revealed that doing experiments and helping kids increased her chemical knowledge.

Participant 6 shared, “It [PBSL activities] helped me working in the lab. I have more understanding of chemistry and it changed me a lot, especially working in the lab.”

Participant 3 said, “It gave me a better grasp on how to do experiments.”

Participant 4 compared doing the experiment with the kids between observing something and participating in the activity. He shared how doing the experiment with the kids was more straightforward than he thought it would be.

Participant 4 said:

> Not my understanding but the difference between watching something on TV and thinking it is amazing and actually doing it and seeing that it is not so complicated when you actually do it.

Interacting with Elementary-School Students

The sub research question, RQ 1.1, asked how did interaction with elementary-school students during a PBSL project affects the GeneralChemistry college students' self-efficacy perceptions in chemistry? Thirty-nine interview responses were identified to address this research sub-question. All the participants indicated, in at least one of their responses to interview questions, that some form of interacting with the kids positively affected their confidence in chemistry. The interaction of teaching student's chemistry was the number one reason given in 20 responses for an increase in the GCCS' perceived increase in confidence in chemistry. Twenty-one of participant responses reported their growth in confidence in chemistry was affected by knowledge of chemistry, enthusiasm, and engagement of the kids. Five answers found the kids asking questions and sharing increased their confidence in chemistry. One participant was challenged by working with the kids but still found value. One other student shared that participating in this project confirmed for her that she had chosen the perfect STEM major.

Teaching the kids chemistry. The pattern for teaching the kids that was most prevalent in seven participant responses for the GCCS' increase in confidence in chemistry was that the kids were younger, and the participants' perceived the students didn't know as much as them. Also, the participants' perceived being prepared to teach and work with the kids made them more confident.

Participant 3 spoke about teaching the kids was a confidence booster for her.

> I think it was a confidence booster because they were younger and don't know everything…I am the one who has to prepare. I go into the experiment knowing what I want to explain to them and how I am going to do it.

Participant 4 shared,

> It definitely made me more confident because they're not my peers. They don't know as much. It felt good to be able to teach what I know. So, it definitely helped my confidence because I knew what I was doing and you just have more confidence and you know what you're doing…you're already kind of confident…because you practice and rehearse what your supposed to teach them. The fact that I already knew what I had to do and how I am going to present, definitely more confident.

Participant 5 said,

> That made me feel very confident because they [the kids] were relying on me for answers and knowing I was able to provide them the answers made me feel

> very, very confident.…I had to learn a bunch of chemistry words and be able to explain it to someone else.

Several participants discussed how preparing, teaching, and explaining the chemistry concepts to the kids, increased their confidence.

Participant 8 said

> After a few minutes my confidence was pretty good. It gave me such a good opportunity to explain in a way that they could understand, and I could reflect on and understand more [chemistry] myself. When they [the kids] were like 'that, makes sense', I knew the way I was explaining it to them, a light bulb went on. That helped my confidence because having someone who has never really looked at science of any kind…be like 'Oh, that makes sense' was really like, 'Yeah, I know what I am doing.'

Participant 3 also reflected, "In service learning we had to get more prepared and give ourselves a better understanding of the material we were teaching the kids…more depth, conceptualizing everything."

Participant 7 said,

> It gave me the motivation and confidence that I could teach chemistry. I was like "wow" I could actually lead something. If I taught little kids, I could do that for other little kids. It gave me the confidence and motivation that I could teach chemistry.

This sentiment was echoed by Participant 10 who said, “It made me feel like I could be a chemistry teacher for elementary school kids.”

Participant 1 shared, “It helped give me a little bit better understanding by simplifying things a little bit more to make it understandable for others and myself.”

Participant 9 spoke explicitly about the need to increase his knowledge to be able to teach the kids. He shared, “[My understanding] was better because you had to understand more to be able to teach better.”

Kids’ interest, enthusiasm, knowledge. Participants shared the excitement, knowledge, and interest the students showed in learning chemistry made an impact on them in various aspects of their perceived confidence in chemistry.

Participant 2 reflected,

> I felt I was able to learn more about chemistry through the kids because one of them had a chemistry set at home. She expressed how she tested different chemicals and how they reacted. That interested me. I feel I want to learn more about chemistry now.

Participant 4 shared how he got engaged when he realized the student in his group had knowledge of chemistry and wanted to learn. He said that his most memorable experience participating in the project was showing the experiment to the kids.

> It has to be when showing the kids the experiment. It was really fun. We had a little girl who knew a lot of chemistry, so it made it more fun because she was really involved and wanted to know it. It was, ‘OK, now we have to teach!’ She

> wanted us to explain things like why this is, why is that that, that doesn't make sense.

Participant 7 discussed the personal impact on her confidence because of the kids' enthusiasm and eagerness to learn.

> It really raised my confidence because some kids were really eager to learn what we were actually doing, and it was eye-opening for me. It was like they want to learn about this and they are so young. It was cool that I was actually helping them reach what they want to be in the future. I am a steppingstone. It raised my confidence because I am playing a part, a role, in helping the kids to get where they wanted. I guess that was part of raising my confidence because I was like, 'Oh yeah, if I can do this, then nothing is going to stop me.'

"It was just cool to watch their reaction and they really enjoyed that. So just having them excited and participating" was Participant 1's most memorable experience of the project. Participant 3 said the most significant part of the project was, "The little girl who had the chemistry set, she actually made doing the experiment fun."

Participant 5 summed up her most memorable experience,

> Seeing the kids happy with the experiments we chose. They were really happy and intrigued. It was exciting knowing our team was the cause of their happiness and really enjoying it, especially the girls' group, because girls aren't really into STEM.

Participant 8 spoke about the impact on her as a STEM major by a student who was shy at first.

> We had a little girl who was very shy and did not seem interested in what we were doing. When she watched the reactions, she really got excited. At the end she said that she would go for science, that it was so much fun. I felt like I was a first responder planting the seeds of science for maybe a future scientist. I remember when that happened to me.

Kids' questions and sharing. The students sharing and asking questions during the project challenged and inspired the participants.

Participant 6 perceived that working with kids was hard because they wanted to learn, share, and ask lots of questions. However, her confidence grew in the process.

> Working with kids is really hard. We had kids in our group who wanted to learn more about chemistry. They kept asking questions and trying to answer the questions because they had a little idea from our beginning explanation. I had a little fear at the beginning but at the end of the day, I had more confidence doing it.

For Participant 3, "the welcoming part…getting to know the kids" was the most memorable part of the project. Her interactions with the students affected her confidence as a chemistry student.

> The way the kids were interacting with me [boosted my confidence] because I knew I was teaching it [the material] and was more confident giving answers and

> feedback to them. It didn't matter that they did not seem super excited because I knew I was teaching them something which was better than nothing.

Participant 9 found the experience nerve-wracking around safety procedures for the lab.

> [The activity] more nerve-wracking, making sure they [the kids] don't touch anything they're not supposed to … Safety procedures, basically, you know it better so you feel safe around them [the kids] telling them what not to touch and what not to do[during the experiment].

Participant 10 said that working on the project, " definitely raised her confidence."

> It made me try to connect chemistry with everyday things in life so I could help better explain it to the kids that we were working with. It gives me more of a personal connection…a more personal connection and makes you more comfortable with chemistry.

Several participants shared the thrill of being with the students and their responses.

Participant 1 said, "I have always had a fond feeling about chemistry. Being able to share that with the kids, I think was helpful".

Participant 7 reflected,

> The fact that some kids expressed their love of science and they wanted to be like an engineer or something in chemistry was really fun to hear. I love it because at such a young age, it's not very often to hear kids talking about science and all that stuff.

Participant 8 summed it up for herself,

> I want to do more service-learning, because the first experience was awesome. I definitely want to do it again, working with kids and showing them that math is fun, and science is fun.

Working on a Team

RQ 1.2 explored how the participants interacting with the members of their team affected their self-efficacy perceptions in chemistry. The question was, how did college students' interacting with other college students on their team during a PBSL project, affect the college students' self-efficacy perceptions of chemistry? I expected working on the team would enhance the students' confidence (perceived self-efficacy) in chemistry. The data was representative of what I thought students might self-report. However, I thought all the experiences reported would be positive, which was not the case. Generally, the overall experience was positive. However, there were several challenges reported by participants working with teams.

For this project, students were randomly assigned to groups using a counting-off method. This process assured that participants on the team would be from a different lab group and lab bench. This arrangement pressed students outside of their comfort zone for teamwork. Members of the team had most probably not worked with any of the members of the team on an experiment.

Team as a resource. The most common pattern of responses to the interview questions relating to the team, were participants' perceptions of the members of the group being a source for knowledge, ideas, support, and collaboration.

Participant 4 spoke that his being part of a team was essential to the success of their project.

> It just goes to show that teamwork is very efficient when people play their positions and do what they're supposed to do. It makes things easier, tasks that look daunting when you break it down, like a chemistry problem, it just seems a lot easier to do. It showed teamwork goes a long way.

Participant 9 shared a similar experience working on the team. "There was a big change in confidence. We worked as a group, so I felt like it's a group thing."

Participants 6 and 7 discussed how being a part of the team was valuable for their future careers in STEM. Participant 7 felt the experience taught her how to work on a team. Participant 6 reported that she was shy and afraid to work on a team.

Participant 6 said,

> I am a little shy but when I was told I would be on a team, I said 'now it's something I have to do - work with a team, with other people'. It's tough so you have to take the fear out and share with others. Before service-learning I had little experience, but now I can do a job with my friend on a team….in service-learning, I learned how to be on a team, and it helped me a lot to work on a team.

Participant 7 shared,

> It [service-learning] showed me how to work on a team, which is part of learning to deal with different people and about confidence. If I could work with my

students [team] I could work with other people in the future – how to deal with such a situation.

Participant 3 "became more confident [in] working with younger and older students…. I think it overall made you better because interacting in different situations."

Several participants acknowledged using the group as a resource for understanding what they were doing for an experiment, sharing ideas, and collaborating on the project.

Participant 2 reflected,

> Teamwork – able to share our thoughts and ideas on how this chemistry lab would go, types of materials we need, and understanding the information on safety. How to cooperate with people, I [didn't] know at first. For my major I am going to have to work with different kinds of people…this was a little bit of a head start for me on understanding how it would work and how I need to operate as a person.

Participant 9 shared a similar experience: "We had to rethink what we had to do from before and instead of taking it from a book, we had to take it from teammates."

Participant 5 was not a student who naturally reached out to ask questions of others. Being on a team made it easier for her to ask for help. Participant 5 reflected,

> I enjoyed working on a team with other people. I also feel that it helped my confidence because I am a type of person that if I need help with something, I won't ask the question,

However, Participants 2 and 3 reported feeling challenged communicating and being understood by their teammates.

Participant 2 reported,

> My confidence went down a lot because I did not know how to talk to my group at the time. I was trying to make the kids interested in chemistry but at the same time learn something. I hardly spoke up about stuff. I lost it because I didn't know how to speak to a group.

Participant 3 had a difficult time getting her ideas across to her group but then she elected to trust them to get their part of the project done.

> [It was] hard to get my ideas across to my team. I was making it too complicated. I couldn't understand why they were confused. They wanted to change it a little. I told them I trusted them 100%. That was new for me because I tend to do things on my own or be the team leader, doing most of the work. It made me feel uncomfortable but better because I didn't give up on them.

Confidence in chemistry concepts. Several participants reported how working on a team enhanced and expanded their knowledge of chemistry.

Participant 9 said, "[I am] better organized. When you're better organized, I feel like you're more confident teaching."

Participant 2 shared the experience of working on a team for the service-learning project helped his confidence a lot.

> I was able to understand chemistry more. I knew about chemistry through the different teams and people. When I first did the experiment, I was really lost. When I went through it with the group step by step, I was able to understand.

"I think it helped not only my teambuilding skills, but it also helped me realize I can start from scratch and put an experiment together," reflected Participant 8.

Participant 1 self-reported himself as a slightly older student compared to some of the members of his group. He acknowledged he was, "a pretty confident chemistry student to begin with…I don't think it changed my confidence necessarily as a student [working on a team]. If anything, I may have been able to help them a bit."

Respect for different perspectives. Participant 10 reported how she learned to be more patient and to respect differing points of view and perspectives.

> It helped me be more patient with people [on the team] because everybody wanted something to add [to the project] whether it was small, and they thought it was a big deal or…it's just a different perspective. We had to work in groups with so many different personalities and different levels of chemistry. You learn to give somebody credit for something that's not so big, but they think it's big.

Participant 8 shared about having mixed experiences with teams in college. Being on her service-learning team contributed to her confidence.

> Our team had a pretty good variety of people with different concerns, strengths…many different ideas on what we should do. I had never spoke[n] to anyone on my team before. It helped my confidence because I know I am going

> to have to work with people, not necessarily friends. This helped my confidence that I can work cohesively with everyone, every kind of group of people.

Participant 5 was the team leader of a group. She shared,

> Since I was the team leader, I was always having to be in contact with other people and making sure that other people were in contact with everyone else…doing what they were supposed to do. That made me feel important…My role as [a] team leader showed me, I could take more initiative when I worked in the lab with my lab partner. It made me "way more" confident.

Developing the PBSL Project

The sub-question, RQ 1.3, studied how participants who engaged in developing the PBSL project affected their self-efficacy perceptions in chemistry. Since the impact of being a part of a team is given a separate research question, I focused on other responses by participants for this research question. More confidence in the participants' knowledge of chemistry and new insights into practical learning skills were the predominant responses from the interview questions on how working on the development of the project enhanced their confidence (self-efficacy) in chemistry. Fourteen of the 31 answers selected for this research question indicated that the development of the PBSL project increased their existing learning skills or gave them a new insight on how to learn more effectively as a STEM student. Confidence in their chemistry knowledge, both in content and lab skill, was identified in 11 responses. Teamwork was acknowledged as a tool by three of the responses for enhancing their confidence in chemistry. The remaining three responses indicated other insights on how developing the project supported their self-efficacy as a chemistry student.

Enhancement of study skills. Two participants shared how developing the PBSL project was an opportunity to prepare like a teacher. They reported, for them, teaching was a useful study tool.

Participant 7 reflected,

> One thing that has changed it's [PBSL project] taught me that teaching other people can be another way of learning yourself. It's changed me to other learning methods…I discovered new methods of learning, especially teaching was a good way of learning it myself.

Participant 9 shared, "I improved…because I tried to know what [I was] teaching versus [just] learning [it]."

Two participants talked about the value to them of the hands-on aspect of the project and learning chemistry. Participant 3 said, "One thing I learned throughout the service-learning planning is that I work better with hands-on rather than reading a text or listening to lectures." This sentiment was echoed by Participant 5, "I learned that regarding chemistry, I am very hands-on, more than reading. I'll read but I work better when things are hands on."

Five participants gained insight into tools to support them in being successful students. They ranged from the value of practicing skills, an excellent way to study, and some insights into study skills.

Participant 3 saw the PBSL project as an excellent way to study. She reflected,

> Participating in the service learning [project] did support my original knowledge of the chemistry work I was doing. It's a good way to study…to better grasp the information and retain it. I think that's an important part of it. It's a good learning support.

The other participants shared insights they learned about what it takes to be a successful chemistry student. Participant 9 learned he "should have reread [the]text more than listen." He also shared doing the project was, "Basically, more practice for what we have [to do] in the future. In service-learning, we had to prepare all the materials." Participant 6 stated, "It [doing the project] supported me in doing calculations and mixing chemicals, and safety protection. It gave me more knowledge."

Participant 4 revealed the discovery of the value of taking notes.

> It helped me take notes…you need to take notes…it's helpful to look back on what you did before and know you can always go back and trace your mistakes, things you could do better. It was definitely helpful.

Two participants found developing the project challenging but valuable for them as chemistry students. Participant 6 shared the project supported her in learning how to do the calculations for her project. She reflected, "In the service-learning project, it was tough at the beginning, but we learned a lot calculating on our own and sharing with the kids [what we learned]." Participant 4

learned that the more effort you put into it, the more you will get out of it.

> Chemistry and service learning are challenging but you just study. I learned obstacles can definitely be overcome…chemistry is not my easiest or my strongest subject…challenged me to go above and beyond what I usually do for most courses. I appreciate I was able to get that out of chemistry…The project let me know I had to study.

In closing, Participant 10 learned through the project that she didn't need to know everything about chemistry. She said,

> I learned that it's okay not to know everything as long as you can relate in a certain way…as long as you can relate then you can get someone interested in the same way you are interested."

Expanded understanding of chemistry. Expanded understanding of chemistry. Five of the 10 participants reported an expanded knowledge of chemistry while developing the PBSL project. Most of the responses spoke to an increase in chemical knowledge. Participant 1 shared that he had, "a slightly better understanding because I had to dumb it down, that it made it easier for even me to grasp." "The service-learning project really helped me dig deeper into what chemistry really is," reflected Participant 7. In a similar vein, Participant 2 said, "I would say [the project] helped me to know more about the areas of [the] chemistry project itself….I would say that I have a lot to learn about chemistry." Developing the PBSL project helped Participant 6 in her lab skills. She shared, "It helped me working in the lab. I have more understanding of chemistry and it changed me a lot, especially working in the lab." This same participant self-reported having more confidence in chemistry working on the SL project. She said,

> Engineering is my major and I did not have much confidence in chemistry. After doing the service-learning project, I have more confidence in chemistry. I might do [choose] chemistry as my second major.

Additionally, two participants indicated an increase in interest and motivation to engage more in chemistry. Participant 2 said working on the project, “helped me build my interest in chemistry.” Participant 7 experienced the confidence and motivation that she could teach chemistry. She reflected,

> It gave me motivation and confidence that I could teach chemistry. I was like Wow…I could actually lead something. I mean when you are teaching something…you prepare for everything and after it is done you are like, oh, this wasn’t too bad. If I taught little kids, I could do that for other little kids. It gives me the confidence and motivation that I can teach chemistry.

Lastly, Participant 6 could see a change in her regarding her understanding of chemistry. She reported, “I can see a change from the beginning of chemistry to the end. It’s really a benefit in my field [engineering].”

Working with the team. Participants 2 and 3 encountered challenges while working with their group. Participant 3 perceived her group was reticent to participate and resisted her suggestions on how to develop the project. While Participant 2 found it challenging to engage with his group to get prepared for the project. Both participants did not let their distress interfere with their participation in the PBSL activities.

Participant 3 reflected,

> It boosted my confidence at the end. The group I was working with were a little to themselves. I had to trust that they were going to do what they said they would do, which made it easier for me.

Participant 2 shared,

> We started out pretty good before the experiment. We had a group chat but when we were trying to get the assignments and stuff on time we were slowed down because we weren't doing much…some were laying low. We were behind but were able to get it done the last day…the materials we needed and stuff for the experiment.

Participant 4 spoke that one of the impacts of being on the team was that he was part of something big, a bigger game to play. It helped him because he was helping others.

> Helped me because I was part of something big. You're not just doing it for yourself but doing it to expose the younger kids to chemistry. It helped me to be helping someone else

Participant 10 disclosed that she was a chemistry tutor and did not change as a chemistry student after completing the PBSL activities. She shared,

> I think as a chemistry student, I looked at it [PBSL activities] from a different perspective. Like more of an explanation of things. I have not changed as a chemistry student. Since I was a tutor and SI (supplementary instructor) [for

> chemistry] for a couple of semesters, I think it's like the same…it's very similar to service-learning. It's just that the kids are a lot younger.

However, she did reflect an appreciation for chemistry after completing the PBSL activities, "I think it made me appreciate it [chemistry] more because it [PBSL activities] gives you so many perspectives…from people from different levels in your group."

Research Findings Related to Reflective Journals

Participants 2,4,8,9 and 10 submitted reflective journals for the PBSL project. The period lasted from the first day of preparation for the project until after the completion of the PBSL activities. Four of the reflection-prompts were the same as the interview questions. Not all the reflective-journal questions were answered by participants. Many of the sentiments shared by the participants mirrored expectations, thoughts, concerns, and apprehensions expressed during their interviews. The reflective journals of the five participants seem aligned with some of the findings presented in their conversations. Whereas the reflections were enlightening, the data obtained did not compare in depth and scope to the rich, descriptive information gleaned from the one-to-one meetings.

Reflection Question 1. The first reflection +prompt asked the question, "what is service learning about?" This question was asked at the beginning of preparation for the project after participants had read three reflections from other students who had participated in previous service-learning activities.

Participant 2 wrote, "Service learning will be a unique experience for me to get more comfortable talking to strangers." This comment was aligned with his expressed concern in his interview about being able to speak to a group, both the kids and his teammates. He said, "My confidence went down a lot because I did not know how to talk to my group…I hardly spoke up about stuff. I lost it because I didn't know how to speak to a group." Participant 4’s responded to the question about the nature of service-learning with a reply echoed in his interview question. He reflected on the value of being part of a team. He wrote, "I think service-learning is a great thing. It is great because it allows the lab-partners…involved to engage…enables them to engage by cooperating [in] activity by doing something." He said in the interview, "It showed me that teamwork goes a long way. Even if the task looks daunting, if people play their role and …do their parts, it [PBSL project] can definitely be accomplished." Participant 8 responded to the same question, writing that she believed she would "thrive during this service-learning project." She continued, "I hope that we awaken some feelings of joy and excitement for them…experiencing a college chemistry lab for the first time." In her interview, Participant 8 shared, “We had this one little girl who got so excited when we brought out the materials. As a chemistry student, it made me realize that when I was that age, I got really excited too and that I am in the best major for me right now." Participant 9 wrote that service-learning was about kids coming into the chemistry lab learning and having fun. He reflected, "My expectation of service-learning is that kids would be here in chemistry class learning about chemistry and …having fun with it. This day we will help kids learn and have fun." However, his responses during the interview were not consistent with his expectations. "It was more nerve-wracking trying to make sure they [the kids] don't touch anything [they're] not supposed to." After reading the service-learning reflections in preparation for the activities, Participant 10 wrote she hoped the students who participate in service-learning, "get a new perspective." Responding to an interview question on how her understanding of chemistry had changed after completing the PBSL activities, she answered that she became aware of many different perspectives. During her interview she confirmed her hope of new perspectives. She shared,

> For me, I think I always knew that chemistry was kind of everywhere, but it's like seeing something in somebody else's perspective….It's just different perspectives again….We had to work in groups with so many different personalities, and different levels of chemistry as well.

Reflection question 2. The second reflection question was positioned after the preparation activities for the project were completed. Students were asked to reflect on doing the project and share their thoughts at this point. Also, to reflect on what value they might get personally from doing the project. Participant 2 wrote, "I think the value, I will get from participating is getting less nervous talking to kids as well as a better understanding of working with younger individuals." During his interview, Participant 2 shared, "I feel a little more confident talking to kids". In the beginning, his team had lots of questions on how they were going to work with the kids and keep them on track. He shared, “I feel I was able to learn more about chemistry through the kids because one of them had a chemistry set at home and asked lots of questions.”

Participant 4 echoed in his journal, writing similar sentiments he had shared during the interview about the positive impact working on a team for the project was for him. He wrote,

> I feel a lot better about service-learning because I got the chance to collaborate with my group-partners. I also feel excited about it now that [we know] what [we] might to. The value that I might contribute to the students who participate with me… is the value of working on a team.

Learning through working on a team is a recurrent theme in Participant’s 4 communications, both written and oral.

Participant 9 expressed concern he thought that doing the project was going to be a challenge working with the kids but that his team could handle the situation and it would make a difference for the kids.

> I feel this is going to be a challenge, but we should or can handle this as we know how this [experiment] works...They [the kids] will gain knowledge and appreciation of chemistry. It will help them use it in everyday life.

During his interview, he reflected that the experience of working with the kids was nerve-wracking. He was concerned about the safety and the students touching or doing things that might be a problem. However, knowing the safety procedures made him more confident. There is no reference in his interview about the kids gaining knowledge, but he did respond that he had improved as a chemistry student because he had to understand it more to teach it.

> It was more nerve-wracking trying to make sure they [the kids] don't touch anything [they're] not supposed to….Safety procedure, basically, you know it [safety procedures] better, you feel safe around them, [more confident] because of knowledge….I improved…because I try to know what [I'm] teaching versus learning. You had to read all the procedure in everything, before teaching it.

Participant 10 wrote she was nervous and excited about doing the project and hoped the kids would enjoy the experience and learn something. Like her response to reflection question 1, she looked forward to a new perspective for her and the students she was working with on the project. She transcribed: " nervous and excited…hope [the kids] will enjoy the experience…spark an interest in chemistry…a new perspective, and a good time." During her interview, Participant 10 shared her most memorable experience was working with the kids. She reflected, "Definitely the kids….I thought that they were so great…they did enjoy chemistry…liked doing the experiment…doing things that are hands on."

Reflection question 3. The next reflection was presented before the elementary students were in the lab. Everything was set up, and the participants were ready to begin the activities. Participants were prompted to write down their thoughts and feelings about the project at this point. Three participants responded to this reflection question. The general sentiment expressed was a combination of being prepared, nervous, and excited about engaging in the PBSL activities with the kids.

Participant 2 wrote, I’m really nervous…don't know if I can do a good job …guiding the kids as well as carrying out the experiment properly…it is up to me and my group to keep this experiment engaging and fun.”

Participant 8 reflected,

> Now that we are fully prepared for the service-learning project, I am both nervous and excited for the children to come in. My teammates are very nervous, but I can also see that things are ready….I do not anticipate anything I cannot handle.

Participant 10, “felt mostly prepared, just a little nervous about what they will be like and what will interest them.” She wrote, “I want them to find some part of the lab interesting.” Her other comment was about the preparation, “I [thought] it was going to take more time to prepare, but it wasn’t difficult at all.”

The next four reflection-prompt questions were the same as the interview questions. These questions were given to participants, on a handout at the end of the activities, after the students had left the lab. At this time, everything was cleaned up and returned to its proper location.

Reflection question 4. This question asked the GeneralChemistry college students’ to reflect on what their participation in the project affected their confidence in chemistry. Four of the five participants responded to this question. Participant 2 felt that he could keep the students on track. He also reiterated his nervousness speaking to the kids.

> I would say having the ability to keep the students on track and not distracted. I was unsure how to talk to them, and a bit nervous because they had so [many] ideas and knowledge they were willing to share.

Participant 8 shared in her reflection that having to explain the experiment to the kids, allowed her to understand the lab more.

> Being part of this service-learning project helped me to understand the lab report even further because I was able to explain it in terms that a small child would understand.

Participant 9 found the experience of teaching the kids difficult but worth his effort and patience. "Teaching was a lot harder than I thought. I didn't expect they [would know] a lot less…I don't mind [it took] more effort and patience to teach them." During his interview, Participant 9's interview response aligned with his reflection response, "I felt I learned a lot more than being taught in a class. Basically, we had to rethink what we had to do from before." Participant 10 reaffirmed her confidence as a chemistry student; "I feel confident in my explanation of the experiment today." However, her response to the same question I asked her in the interview dwelled on her awareness and appreciation of the various perspectives of members of her team and the kid.

> I think it made me appreciate it [chemistry] more because it [service-learning project] gives you so many perspectives. [Perspectives] from people from different levels in your group and also the kids themselves.

Reflection question 5. This question addressed what they had learned about themselves as chemistry students. The same four participants responded to this reflection-prompt as reflection question 4. The themes of their writings were like ones they had shared before. However, their interview answers of all participants were not consistent with their reflection responses. Participant 2 reflected on his challenging in expressing his ideas with a group and working with the kids. Participant 4 wrote about her experiences teaching and working with the kids. Participant 9 shared about his experience teaching and Participant 10 reflected on the impact on her as a chemistry student teaching the kids.

Participant 2: “I learned I am capable of working with kids but not able to direct them in the right direction. Also, I learned that I have trouble voicing myself in a group of fellow classmates.” Participant 8: “I learned …there are a lot of topics that are different for a young child to understand. Explaining to chemistry students is not difficult. As a STEM major I learned that …in an environment where I am not actively participating in the lab, I still enjoy the experiment.” Participant 9: “I cannot teach and …be a teacher. It was very awkward to teach since they stare at you with blank faces.” Finally, Participant 9 reflected, “I learned that sharing information with kids helps me remember why I love it [chemistry].

It is useful to remember that the journal reflections were on the same day that the project was done while interviews occurred after the course was completed. In some cases, I met with the participant within a month of the completion of the project while others I interviewed later. It is understandable that over time, the participants’ experience, and value received from participation in the PBSL activities might alter. This time variation presents a possible explanation for the discrepancies in their answers to identical questions.

Participant 2's interview response to this question on what he learned about himself as a chemistry student from the project was relevant to the question. He spoke about how chemistry at the college level was very different than high school. In college chemistry, you were required to understand more and to give explanations. Also, he commented that the PBSL project got him more interested in chemistry.

> I would say that I have a lot more to learn about chemistry. In high school, it was more about understanding different atoms and molecules, while college is more about you need to understand why this happens and what happens after that and how the combinations affect the different types of chemical outcomes. Also, I would say it helped build my interest in chemistry.

Participant 8 echoed her theme about loving the lab experience during the interview.

> I learned that I had a lot of fun, and I love science. I love the laboratory setting. My favorite thing was setting everything up and getting prepared – the anticipation. More than anything else, I learned I was in the best major for myself that I really love it.
>
> Participant 9 shared only one thought during the interview in response to this question. What he learned about himself as a chemistry student is that he "probably should have reread the text more than listen." Participant 10 in the

interview discussed she learned it was okay not to know everything when she was teaching the kids. What was important in working with them was to be related to them and to be interested in your subject.

> I learned that it's okay not to know everything as long as you can relate in a certain way. I think because as long as you can relate…you can get somebody interested in the same way that you are interested. It is always okay to ask questions. As long as you have an interest, they're going to have an interest too.

Reflection question 6. This reflection-prompt asked the student to ponder how their participation in the service-learning activities supported them as chemistry students. Participant 2 thought the experience was an excellent introduction to teaching. He also added that the project showed him he still had a lot to learn about chemicals.

> I would say that this experience was informational and a good opener to teaching. It showed me how much I still need to learn on working with chemicals and how it [the experiment] is to run

In his interview, at a later time, Participant 2 shared that the format of their activities with the kids helped him to understand chemistry better.

> Our activity used a question and answer format, like why is this reaction happening? It was hard to come up with the questions and the correct answers. That helped me know more about the different types of tasks for the chemistry students to learn.

Participant 8 focused on getting kids interested in science in her journal entry and her interview. She wrote, “By participating in this experiment, I was able to help interest the students in science.” During her interview, this participant remarked,

> I want to do more service-learning because the first experience was awesome. I definitely want to do it again working with kids and showing them that math is fun and science is fun.”

Participant 9 wrote in his journal for a response to this question the need for more knowledge. “I need knowledge of chemicals.” During his interview, he shared that doing the project was a way to get more practice for his future career of working with chemicals.

> Basically, more practice for what we have in the future…our jobs in preparing and using chemicals. In the service-learning project we had to prepare all the materials…label everything and then do precise measurements so when the kids came, we could actually show them without messing up the whole thing.

Participant 10 had two different responses to this question in her journal and interview. In her journal, she wrote she learned was able to bring real-life chemistry examples to the discussion of the experiment. “I was able to bring real-life experiences of chemistry facts like HCl is an acid in your stomach.” During her interview, she reflected the format of the project was that the team members were to coach the students to do the experiment. The team members were not to do the experiment for the kids. She said,

> It supported me in communication because you're only supposed to let them to the experiment…you can't touch anything. That was really hard [for me]. I could only look at what they were doing. That helped me with not doing to much.

Reflection question 7. "What was your most memorable experience participating in this project?" was the next question for reflection after the completion of the activities. All four respondents wrote in their reflective journals about their experiences with the kids. Three of the four participants had similar responses during the interview. Participant 2 wrote his most memorable experience was talking with the kids. He was impressed with how much they knew about chemistry.

> I would say talking to the kids. The students were really smart individuals, even though they're different in skills/knowledge. They were actively engaged while working with us.

During his interview, he remarked on one little girl who made it fun to experiment. "The little girl who had the chemistry set, she actually made doing the project more fun. She was able to share her experience but, at the same time, to stay on task."

Participant 8's most memorable experience was watching the reaction of the kids to the reactions. She wrote, "My most memorable experience was watching one of the student's faces when the reactions were occurring. She looked absolutely thrilled when one of our mixes accidentally bubbled over." During the interview, she reflected on how the two students they worked with, although different in their knowledge of science, had similar reactions to the experiment.

> We had a little girl who was very shy and did not seem interested in what we were doing. We had another girl who was very excited, [and] was older but had some experience with science. When we put the goggles and gloves on her [the shy girl] she began to get excited. When she watched the reactions, she got really excited. In the end, she said that she would go for science that it was so much fun.

Participant 9 reflected how he forgot how simple changes are fascinating the first time you see them, and then you forget. He wrote, "When they [the kids] see the color changes [it] creates a smile or excitement. Simple chemical changes can cause smiles in kids, and we forget all about it." However, when asked this question during the interview, Participant 9 reported his most memorable experience was how long it took to prepare the experiment. He said, "My most memorable experience was how long the procedure, prepping work took [compared to] the actual experiment." Participant 10 wrote about it was a joy to do the experiment with the kids. "I already loved the kids before [we started the] service-learning [activities], so this was really my pleasure." During her interview, Participant 10 shared, "Definitely, the kids…I thought they were so great…I think they did enjoy chemistry. They liked doing the experiment; they liked doing things that are hands-on."

Reflection question 8. The final reflection question asked the participants if they would like to share anything else about their participation in the PBSL project. All participants who submitted reflective journals (five) responded to this reflection. Many of the themes reflected in their previous observations are also present in this final question. Participant 2 thought the overall experience was worthwhile. He still spoke about his challenge of being able to express himself. He wrote,

> I would like to say that this experiment could have gone worse. I still wish I had worked with people I knew so that I could speak more easily. Overall, the experience was fun and worth the time.

Participant 4 reinforced his idea that working on a team helped him as well as supporting the students.

> I feel a lot better about service-learning because I got the chance to collaborate with my group partners. The value that I might contribute to the students who participate with e in this [project] is the value of working on a team. I might receive value…helping students.

For Participant 8, the PBSL experience was enriching and satisfying. Although she was nervous in the beginning when the kids came in, she wants to do another service-learning project.

> I would like to share that while I was nervous and had never done anything similar before, I would absolutely love to do another service-learning project. I thoroughly enjoyed being a part of this service-learning project and learned a few things about myself as well as learning about our students.

Participant 9's takeaway was that he needed to become a better speaker so that when he spoke the kids would have confidence in what he said. He reflected, "I have to be a better speaker. Not be too shy, but able to have confidence in what I say so kids can understand have faith in what I'm saying." Participant 10, consistent with her insight about the importance of being related to the kids, summed up her experience and relationship with them. She wrote, "In the end, they stacked their name tags on me, and I thought it was really sweet."

Findings of the Research Study

The findings of this study revealed that PBSL is a viable strategy to enhance the perceived self-efficacy of GeneralChemistry college students in the domain of chemistry and support them as STEM majors to persist in their academic goals. The local problem that prompted this study was the low rate of persistence to graduation of students who declared themselves to be STEM majors at a northeastern community college. General chemistry is a gateway course for most STEM majors, and success in the class is critical for the students to move forward towards their career goals. The research questions explored in this project study gathered data on the pedagogical strategy of PBSL activities as a possible intervention to improve student retention through the enhanced perception of self-efficacy in the cognitive domain of chemistry.

Bandura's model of perceived self-efficacy was the conceptual framework for the research study. The guiding question for the research was, how do GeneralChemistry college students perceive their relationship between self-reported self-efficacy in chemistry and project-based service-learning after completing PBSL activities? Sub-questions investigated how the GeneralChemistry college students' interactions with the elementary school students, the members on their team, and the development of the project affected their self-efficacy perceptions in chemistry. Four themes emerged from the coding of the data (from the one-to-one interviews and reflective journals), which were self-reported as enhancing their self-efficacy: increase in chemical knowledge, interacting with the elementary school students, being part of a team, and overall participation in the project.

Participants shared that their self-confidence (self-efficacy) increased by their gain in chemical knowledge from participating in the PBSL activities. Previous research supported the increase in the cognitive domain after participating in SL activities. Astin, Vogelgesang, Ikeda, and Yee (2000) reported that interest in the academic content of the project was significant in students who reported a positive experience of service learning. Students writing reflections about their service learning experiences revealed an increase in academic understanding of the subject matter. Analysis of data showed significant positive effects on all academic measures chosen by the researchers for students who had engaged in service learning activities. In a research study, Davis (2013) explored the difference in cognitive outcomes for a course between students who participated in a short-termed service learning experience and a control group who learned the information watching an exemplar video. Findings from this study suggested a greater positive connection between service learning and cognitive enhancement compared to the control group. This study supported my project, which is a short-termed service learning experience for the students.

A service-learning project was done with general chemistry students and at-risk high-school chemistry students (Lee, 2012). The research study assessed the impact of tutoring on the grades of high school students and the chemistry students' perceived self-efficacy after participating in service learning activities. One of the reported results from the project was the positive impact on attitude about chemistry and learning chemistry described by the college students participating in the project. A service-learning project in anatomy and physiology involved community college honors students who tutored at-risk high school students (Ellerton, Carmona, & Tsimounis, 2016). Using reflections as a source of qualitative data, the community college students consistently reported on gains in their cognitive understanding of the subject matter. A study engaged in a tutoring program involving university chemistry students with high school students (Saitta, Bowdon, & Geiger, 2011). A survey administered at the end of the semester was used to assess the service-learning experience of college students. Eighty-five percent of the university students reported a deeper understanding of the academic material. Similar results were documented in other SL research projects (Ellerton, Carmona, & Tsimounis, 2016; Keshwani & Adams, 2017). This previous research supported the findings of my study that one of the outcomes of participation in service-learning activities can be an increase in the cognitive domain of the subject involved in the course. Also, the General Chemistry college students in my study reported that this increase in chemical knowledge after participating in the PBSL activities increased their perceived self-confidence (self-efficacy) in chemistry and as STEM majors.

Earlier research studies supported the findings of my investigation on the impact on perceived self-efficacy enhancement because of engagement with others in service-learning activities. Sivalingam's (2017) results found students who participated in service-learning activities scored higher on being more engaged in the subject matter and enjoying the experience of learning through sharing with others. Bielefeldt, Patterson, and Swan (2009) measured the impact of PBSL in terms of the influence on student-identity as engineers. Many professors who used PBSL noted that the PBSL learning strategy is more motivating to students than standard laboratory or classroom pedagogies, and greater engagement is related to higher retention as STEM majors.

In my review of the literature on previous studies, I found one study by Keshwani and Adams (2017), where students from the college of engineering worked with education majors to develop after school STEM activities. The engineering students were part of a team with the education majors preparing activities for the STEM club. The findings of the study reported that participating in these actions enhanced the engineering students' sense of their ability to be successful engineers. These findings are supported in my research that working with others to develop the PBSL activities enhanced their perception of themselves as capable chemistry students and STEM majors.

Bandura proposed that mastery experience, vicarious experience, verbal persuasion, and emotive state were the kind of encounters that enhanced the individual's perceived self-efficacy. In this study, the General Chemistry college students reported an increase in self-confidence in chemistry, working with the kids, preparing the project, working on a team, and overall participation. Except for two students, the other participants in the study shared through interviews and reflective journaling a heightened increase in their confidence as chemistry students and STEM majors. In their self-reporting, the experience of designing the PBSL activities allowed the students to go through a mastery experience. The General Chemistry college students had to choose, design, and implement PBSL activities in chemistry with elementary school students. This task challenged their ability to use their chemical knowledge to teach the kids.

Working on a team gave them another opportunity for a mastery experience of learning to produce an event and work through the problems and roadblocks in carrying out the task. Also, there were occasions of vicarious experiences. Some participants shared in their interviews that when they were stuck in understanding a chemistry concept. Working with students on the team who were able to explain the ideas to them allowed them to see that they also could understand. They could see peers who had been successful in figuring out the problem. Likewise, on other topics, they could be that resource for another team member.

The phenomenon of verbal persuasion was evident in their remarks about interacting with team members when they were supporting each other. The positive impact of verbal persuasion was most pronounced in the comments from the kids. The General chemistry college students were like rock stars to the kids who looked up to them and were impressed in what they knew and were able to explain. These types of interactions with the kids boosted their image about themselves as STEM majors and their ability to be successful students

The emotive and affective state of the General Chemistry college students was affected by the tension they experienced being concerned they would do an excellent job with the kids and would be able to inspire them to be interested in science. Fear of the project failing or disappointing the kids was an impetus to keep them working on the project and not give up. This experience of not quitting gave them confidence that they could be successful in the face of challenges; they could do it. Likewise, the exhilaration of the success of the project gave them confidence in their ability to teach others. Most of the participants indicated they would love to do more service-learning opportunities. Bandura's model proposes that these types of experiences can cause a shift in an individual's perception of their ability to be competent in a cognitive domain.

Implementation of the Research Findings

The findings of this research suggested that PBSL is a useful pedagogical strategy to enhance the perceived self-efficacy of General Chemistry college students' in the cognitive area of chemistry and as STEM students. This project explored General Chemistry college students' perceived self-efficacy in chemistry after completing PBSL activities. The salient data for the research was derived from one-on-one interviews. I used reflective journals of five participants to triangulate the data obtained from the participant responses. Bandura's (1997) model of self-efficacy guided the study. Bandura postulated there were four accesses to self-efficacy in the cognitive domain:

mastery enactive experience, virtual experience, verbal persuasion, and affective and emotive experience. During the interviews, I asked participants how participating in PBSL activities affected their self-confidence in chemistry or as a chemistry student. Also, one of the questions asked was regarding their most memorable experience doing the project. I directed the interview questions towards how their experience developing the project, being part of a team, working with the elementary school students, and their overall participation in the project affected their confidence in chemistry and being a chemistry student. All interview responses were coded in alignment with the four research questions in categories: chemical knowledge, developing the project, working on a team, and teaching the kids.

Two participants offered contradictory responses to the interview questions. These outlier responses were included in the findings to demonstrate that students had varied experiences doing the project. In one case, the participant was an older student who had a very positive experience of chemistry coming into the course. He enjoyed doing the experiment with the kids and seeing their reactions. He reported that the PBSL activities had mostly no impact on his self-confidence in chemistry because he was already self-confident. The other participant was a supplementary instructor in chemistry for two semesters. She shared that her self-confidence in chemistry developed while being a supplementary instructor. In her experience, PBSL was a similar opportunity to build one's confidence in chemistry. Both participants reported they found value in participating in the project; the data reflects their attention focused on teaching the kids.

The results of this research indicated that PBSL activities for General Chemistry college students enhanced their perceived self-efficacy as chemistry students and STEM majors. These findings are meaningful because the PBSL experience can support STEM students in retention and persistence in STEM courses and as a STEM major. This teaching strategy, to be effective, needs to be structured in a way that offers several opportunities for students to enhance their perceived self-efficacy through mastery experiences, vicarious experiences, verbal persuasion, and emotive encounters.

Concerning sharing the findings of my research, I wanted to reach as many STEM faculties as quickly as possible. I weighed various methods of sharing my results: The inquiry I engaged in was what would be the most effective vehicle to present the findings of my research and make the most significant impact on STEM retention and persistence? I envisioned four possible methods of dissemination of the results and sharing about PBSL. The first was to focus more on the STEM faculty at my institution rather than branch out to other colleges. This strategy would be in the form of a workshop to share the findings and train faculty in how to create PBSL activities that could result in an increase of perceived self-efficacy by the students. Another idea was to produce a manual with the findings from the study, an overview of self-efficacy as defined by Bandura, and steps to create productive PBSL activities for a course. This manual would be made available to the STEM faculty at my institution and anyone interested in using PBSL in their classes.

I also considered being a presenter or facilitating a symposium on PBSL and STEM at a regional or national STEM or service-learning conference. Finally, the one I decided on was to lead a 2-day discussion on PBSL for STEM majors, with STEM faculty teaching at all the community colleges in my state. I chose this approach to publicize the information because I felt that initially to present my findings and mentoring faculty to produce productive PBSL activities, I needed to make the sample population one that was a representative sample and that I had more control over. This initial professional development (PD) conference would allow me to see what worked and what needs to be provided to ensure that participants are supported in having a positive, empowering experience. Also, the conference, open to STEM community college faculty in the state, will help to evaluate the possibility of scaling up the project. I can treat the 2-day PD conference as a pilot to fine-tune for future deliveries.

Section 3: The Project

The findings of the project study suggested that PBSL is a pedagogical strategy to increase students' perceived self-efficacy in the cognitive domain of chemistry. The primary goal of the proposed PD project is to create a cohort of STEM community college faculty trained in developing effectual PBSL activities designed to enhance students' perceived self-efficacy in the cognitive domain of STEM subjects. Also, another goal of the proposed PD project is to create a community of practice (CoP) of STEM community-college faculty pledged to develop PBSL activities in their courses while supporting each other in the realization of that objective.

Rationale for the Professional Development Project

The rationale for doing a professional development project, face-to-face conference is to allow faculty to work together as a CoP in a face-to-face environment immersing themselves in the pedagogy of PBSL. This format was chosen over an online or webinar approach. A study by Chobani (2018) suggested that for professional development interventions to have longevity, face-to-face attendance was an effective strategy. Also, a structure of mentoring and intrinsic motivation were keys factors to the successful implementation of the newly learned pedagogical strategies (Botham, 2018). The CoP has demonstrated being a solid structure with college and university faculty to encourage and support persistence in instructional change (Henderson, Beach, Finkelstein, 2011; Shufeng, Herman, West, Tomkin, and Mest, 2019)). When introducing a new educational strategy, spending time together allows for meaningful exchanges that are not always available on online or webinar formats. Bringing STEM community college instructors together can create a statewide CoP of mutual dialogue and support. Participants can be informed of the status of STEM majors' persistence and attrition, increased self-efficacy as a possible intervention to the problem of STEM significant attrition, and PBSL as a pedagogical tool to increase STEM students' perceived self-efficacy.

Review of the Literature

The genre I chose for the PD project is a 2-day conference for STEM faculty in the 15 community colleges in the region of the country of the research. I performed a scholarly review of literature in the last 5 years on professional development for higher education faculty. The themes that emerged in my literature review relative to the choice of a PD conference as the strategy to share the results of my research were the value of professional development in higher education, value of PD for STEM faculty, incentives and barriers for faculty participating in PD, strategies for active PD, and PD for instruction for effective implementation of service learning.

Value of Professional Development

PD opportunities for college professors made a significant contribution to more engaged and competent instructors. In a qualitative research study, Al Chibani (2018) explored the effectiveness of PD programs for university faculty. Research questions asked participants to self-report to what extent did engaging in a professional workshop series support professors applying new knowledge about teaching skills and methods in their classrooms, daily teaching, and help them in understanding student-centered approaches to learning. Findings suggested that faculty engaged in PD activities were more aware of various teaching strategies and resulted in improving their teaching skills. All the respondents in Chibani's study indicated that their teaching methods had become more student-centered and less traditional, and "now their teaching skills became more active" (p. 57).

In another study, researchers investigated how college teachers perceived the effectiveness of PD programs by distributing a questionnaire for feedback and suggestions (Malik, Nasim, & Tabassum, 2015). The participants recommended that the focus of PD programs be relative to classroom problems of students, and practical training in innovative teaching strategies. A follow-up component of the study was to have participants share their experiences after the innovations were implemented. The use of reflective practice by teaching faculty was emphasized as an essential component of effective instruction. Training in reflective writing was recommended since, "in the current era, reflective practice is an important component of effective teaching" (Malik, Nas, 2015, p. 184).

Studies by Kirpalani (2017) and Wlodarsky (2018) explored the use of reflective writing as a useful tool for improving teacher effectiveness. Kirpalani's research reviewed relevant literature on faculty members' self-reflective practices in higher education. She proposed actions to get started on the reflective process, including the possibility of being collaborative with other faculty members in the process. She stated that self-reflection was a simple strategy to begin the process of evaluating an individual's teaching practices to develop into a more effective instructor. Wlodarsky (2018) engaged in a qualitative study from a voluntary sample of faculty at a private liberal arts university. This study explored the use of self-reflection in the professional context of how reflection impacts the growth of an instructor. The research questions inquired into what did the reflective process look like for individual faculty members, and how might a practice of reflection affect their professional development as instructors in the classroom? Wlodarsky's research reported that most instructors employed a similar structure in their process to reflect on teaching practices, and this approach to self-evaluation stimulated learning and contributed to their development as effective teachers.

Given the present COVID-19 epidemic, the idea of PD through blended learning or online technology seems a more practical choice. Hilliard (2015) engaged in a study reviewing the literature on the many aspects of blended learning, such as benefits, terminology, team support, evaluation, professional development, etc. Her findings suggested that a blend of online and face-to-face instruction may be an ideal strategy to reach the different learning styles of students. She also stated that blended learning could be a useful tool for faculty PD.

Soto, Gupta, Dick, and Appelgate (2019) engaged in a study to evaluate a program they used which employed online technology to create a CoP to support them in the use of the lesson-study approach to their PD. Because they were geographically at great distances from each other, using online technology seemed the most appropriate method to use for their project. Their research question inquired into how the use of online technology for a lesson-study supported the PD of higher-education faculty? Data was collected and coded for emerging themes. Findings suggested that the use of online technology for this project transformed the lesson-study process and gave each participant an insight into each other's experiences of teaching. They saw the use of technology in this activity as a valuable tool to bridge distances between instructors who wanted to engage in a CoP. This experience empowered the researchers to continue to work together on a variety of exploration activities.

One of the challenges in PD programs is an assessment of their value and usefulness to the participants. Chalmers and Gardiner (2015) investigated how PD developers can assess the effectiveness of their programs. An evaluation framework that was relevant, rigorous, yet flexible was recommended to be implemented to guide the collection and analysis of data. This information could be used to inform future practice.

Another theme revealed in my review of the literature and relevant to my project was how to engage faculty in participating in PD opportunities. In a study conducted by Botham (2018), the RQs focused on why participants had engaged, chose not to join, or barriers to their participation. The study, a mixed-methods approach, used a questionnaire and semistructured interviews. A desire to develop as a teacher and gain recognition for their teaching and learning activities, along with departmental support, were strong influences on faculty participation.

With similar findings, Lodhi and Ghias (2019) engaged in a quantitative study to highlight challenges encountered by university faculty who participated in PD programs. Also, the research sought to evaluate administrative support for participation and recognize any workable strategies for better enactment. A descriptive, cross-sectional survey instrument was used to gather opinions from participants. Three main discoveries came from the research. The overwhelming number of respondents to the survey reported that a lack of reward and recognition was their biggest complaint. Secondly, faculty members reported the lack of workload accommodation for the time spent working on the PD project, and implementation was a deterrent to future participation. Finally, the third sentiment expressed was the resistance of their department heads to allow faculty to incorporate innovations in their courses. The researchers recommended a financial incentive in the form of a bonus or advancement attached to the training might make participation more worthy to the faculty member.

Another study explored teacher resistance to participate in PD (Deaker, Stein, & Spiller, 2016). Four assumptions about faculty resistance to PD from a study done by Quinn (2012) were used to guide the participants to express their views on professional development. A questionnaire using a Likert scale and open comments, based on these assumptions were distributed to over 2000 academic staff within two universities and one polytechnic institution. The results of the investigation revealed that faculty saw themselves more as researchers, rather than teachers, that students were the problem of learning, teaching is a technical skill, and education theories are not needed.

Administrators only care about teachers' performance as a marketing tool. The results of the study suggested that the reasons for teacher resistance to PD are much more complex and nuanced than the stated assumptions in Quinn's work. The researchers advocated, "provision for teacher education to be seen as an integral part of academic identity and development, and to promote environments that encourage more enabling discourses" (Deaker, Stein, & Spiller, 2016, p. 310).

STEM Professional Development

A literature review of research studies on a traditional PD format for STEM faculty was limited to one research project conducted with biology post-doctoral faculty. The study was a longitudinal study that explored the perceived effectiveness of a Faculty Institutes for Reformed Science Teaching compared to faculty not having done the Faculty Institutes for Reformed Science Teaching PD program (Derting, Ebert-May, Henkel, Maher, Arnold, Passmore, 2016; Emery, Maher, Ebert-May, 2019). The research method included a multitude of surveys for faculty participants. Instrument-collecting data points included video-recording of classroom teaching practices and questionnaires to students in the participant's courses. The findings of the study indicated that the pedagogical practices learned in the Faculty Institutes for Reformed Science Teaching PD program lasted long-term in the faculty's careers and were more student-centered in their structure. Faculty with more teaching experience did not engage in a more student-centered approach to learning and might benefit from professional development. "A core objective of teaching professional development programs is to change instructor attitudes, approaches, and teaching practices" (p. 15).

I found two research articles that investigated how to affect lasting change in the teaching pedagogies of STEM faculty. Each study represented a review of the literature on this topic. Gormally, Evans, and Brickman (2014) reported on the lost opportunity to effect change in teaching practice using feedback. Whereas workshops are useful in introducing new ideas and pedagogical strategies, changing in teaching was more likely through formative assessment in the form of coaching and comments.

Another study reviewed almost 200 articles on the current scholarship about how to change instructional practices for STEM courses (Henderson, Beach, Finkelstein, 2011). The findings suggested four categories of change strategies: disseminating curriculum and pedagogy, developing reflective teachers, enacting policy, and developing a CoP of a shared vision. The PD conference I am planning will include CoP and reflection as part of the design. One approach to PD that was not effective was the drafting of best-practice course materials and distributing them from a top-down approach. Effective change strategies occurred when the implementations involved long-term interventions and sought to change the instructional beliefs of the participants. A limitation of this study was the lack of strong evidence to support the success of the change strategies for undergraduate STEM instruction.

Building on the previous study, Borrego and Henderson (2014) researched how educational practitioners can effectively change pedagogy in STEM education. The article offered four possible strategies to affect change in STEM education based on change strategies proposed by Henderson. For an individual teacher, change can come through the prescription of information or empowerment. Institutionally, a shift in the paradigm of teaching can arise through enacting a new policy that required or empowered new practices or empowering faculty collectively to develop environmental features that encourage new teaching practices.

Recent studies concerned with improving STEM education investigated a less formal structure of PD where interested faculty use social networking to share curriculum innovations or create a CoP as the structure for their PD. One mixed-methods study explored the relationship between faculty who use learner-centered pedagogy and their interconnectivity in a social network in their department (Middleton et al., 2015, October). Each participant in the study completed a survey and participated in a one-to-one semistructured interview. The interview focused on their teaching practice, support, and the barriers they faced in trying to improve their teaching. Faculty who self-identified as learner-centered in their instruction reported a more in-depth and more extensive social network. The researchers recommended more intra-departmental and inter-departmental faculty professional development experiences for faculty to introduce and support innovations in STEM curricula. Shufeng, Herman, West, Tomkin, and Mest (2019) studied the effect of a CoP structure for PD and the use of evidence-based instructional practices (2019). They compared social interaction with a control CoP that was not engaging in evidence-based instructional practices activities in their classrooms.

The results of a sociometric survey to 120 members of CoPs indicated that all participants in the CoP networks had meaningful interactions. The participants in the evidence-based instructional practices CoPs revealed a larger core and more active memberships. Findings indicated that a model of collaboration in a CoP can be a catalyst for a larger-scale change in teaching practices. A few stakeholders in the CoP can drive the reforms and support a group consensus to adopt the changes.

Likewise, McConnell, Montplaisir, and Offerdahl (2019) studied social networking as a vehicle to diffuse teaching innovations in a STEM department. A survey was distributed to all STEM teaching faculty to ascertain what differences in self-reported assessment practices are used, to what degree do colleagues interact with instructors who use assessment practices, and to what extent do instructors, on all levels, interact with each other? Results of the survey indicated "… instructors with higher self-reported assessment experience had more teaching-specific peer interactions within the department" (p.1). Findings suggested that increasing opportunities to interact about teaching could give STEM faculty exposure to more useful ideas for faculty professional development.

The impact of undergraduate course innovations in science on student learning employing a review of the literature was investigated by Ruiz-Primo, Briggs, Iverson, Talbot, and Shepard (2011). Research questions inquired into the influence of science-course innovations on learning science, what kinds of changes were used, and do student-centered innovations in science courses have a positive effect on student learning? The data suggested that course interventions in biology, chemistry, engineering, and physic have a positive impact on student learning. The validity of the findings was challenged because the reviewers found the research methods used were frequently not up to the standards of academic scholarly research.

Geoscience college faculty explored strategies to improve teacher instruction, institutional change, and PD programs to empower effective teaching in the classroom (Bitting, Arthurs, Chapman, Macdonald, & Manduca, 2018). One of the research questions focused on the role of PD experiences in facilitating the growth of geoscience instructors' teaching practices over time. One recommended strategy was to engage in a longitudinal study to explore instructors' growth in teaching practices. Another suggestion was to design protocols for follow-up interviews and observations with participants to evaluate the impact of participating in PD programs on their practices in the classroom.

An analysis of over 200 studies of traditional style lecture vs. active learning activities compared examination scores and rates of failures for students in STEM courses (Freeman et al., 2014). Active learning involves students being engaged in the classroom with various activities rather than being passive listening to a teacher considered to be the expert. Test scores increased by about 6% in active learning sections compared to students in traditional learning classrooms who are 1.5 times more like to fail the course. "The results raise questions about the continued use of traditional lecturing as a control in research studies, and support active learning as the preferred, empirically validated teaching practice in regular classrooms" (p. 8410).

The necessity of long-term structured institutional support for PD was emphasized in two research projects. A study by Borda et al. (2020) focused on improving learning in introductory STEM courses by assisting faculty in implementing student-centered pedagogies. This mixed-methods research project included a 4-year institution and two 2-year colleges over four years and was a combination of survey and case study. Also, a student-perception questionnaire was administered. The research questions focused on what interventions faculty had used to improve student understanding of the material, what supported or hindered their implementations, and how did their changes align with students' perceptions? The researchers' data suggested that transforming classroom instruction is complex and requires working across disciplines. Faculty development for student-centered learning is a life-long process and "institutionalized, sustained faculty development is required for lasting change"(p. 16).

The American Association for the Advancement of Science commissioned a report to assess the state of reform in STEM in undergraduate instruction and to identify the levers for change in STEM college teaching (Laursen, 2019). The research questions centered around assessing the current state of research-based instructional strategies reform in undergraduate STEM instruction for six cluster disciplines. Findings indicated faculty awareness of research-based instructional strategies had increased. Still, the inclusion of these strategies across many disciplines and in-depth is not yet widespread, including teaching to a diverse student population. The report found, "active learning experiences are good for students and support their learning, attitudes, sense of belonging, and persistence in STEM" (Laursen, p.9). The report stated that changes were required for research-based instructional strategies to be embedded in undergraduate STEM education. These changes included institutional support, department changes, rewards and incentives, and changes in internal and external policies at the institutions and must consist of collaborative multilevel approaches. The recommendations of the American Association for the Advancement of Science are aligned with faculty sentiments about their resistance to participate in PD, as indicated by research studies of Botham (2018) and Burdick and Doherty (2015).

Professional Development for Service Learning

I identified four scholarly articles that addressed professional development for improving service-learning activities. In a review of the literature, Keith (2016) discussed the importance of service-learning projects that were created mindful of the needs and interests of the community being served, i.e., cultivating practitioners of a democratic civic engagement experience concerned with the community. Likewise, Studer, Benton, Rogers, and Quirke (2017) proposed, in an essay, that faculty development for service learning should be immersed in collaboration with community stakeholders. "Faculty development …should not happen solely within the confines of an academic institution" (p. 153). These two studies point to the importance of having service learning be focused on contributing to what the community needs rather than what the academic institution believes it can provide.

The other two studies focused on the design of service-learning projects. One study explored how backward design principles were used for creating service-learning projects (Jozwik, Lin, & Cuenca-Carlino, 2017). One RQ investigated the perceptions of the effect of this design by students and community stakeholders. Results suggested that the use of backward-design strategy, when done in collaboration with community stakeholders, resulted in a mutually beneficial service-learning project. Maddux and Donnett (2015) discussed the importance of reflective writing in the service-learning experience. In particular, the researchers, using Dewey's theory of pragmatism, examined service-learning participants' use of reflection. The authors' stressed the importance of a critical assessment of one's service-learning experience in changing belief systems about oneself or others. "The whole purpose of inquiry, what service-learning practitioners call reflection, is to determine exactly how and where our guiding schema shift as a result of experiences that pose problems of knowledge" (p.67).

Project Description

A 2-day professional development face-to-face conference was created to educate STEM faculty on the current status of STEM majors' persistence and retention, the findings of my project study, and train faculty in effective implementation of the pedagogical principles of project-based service-learning. The absence of a vaccine for the coronavirus, at this time, can support this conference in a Zoom teleconference format. The target audience for the workshop is STEM faculty in the community colleges in the state of the New England community college. The Day 1 schedule (Appendix F) of the professional development conference will begin with a focus on the persistence and attrition statistics of STEM majors nationally and statewide. I will introduce Albert Bandura's (1997) cognitive distinction of perceived self-efficacy and present studies that suggest the impact of self-efficacy on student persistence and retention for STEM majors. Also, as part of the first-day content, there will be a presentation and discussion of project-based service-learning as a pedagogical tool to increase perceived student self-efficacy in the cognitive domain of STEM courses. The day concludes with testimonials from students who participated in PBSL activities and community stakeholders who have been partners in PBSL projects in the community for several years. The endorsements will create a context for the value and need for PBSL activities for the community. Former students who participated in the project will share their experience doing the project and the value they have received as STEM majors by being involved in the project. Community stakeholders will attest to the need for such a project in their elementary, middle schools, and youth organizations.

Day 2 (Appendix G) in the conference is designed as a practicum, a hands-on opportunity to learn how to develop useful PBSL activities for one STEM course. The structure of the sessions will include coaching for actions to provide a mastery-experience for the STEM students. Participants at the conference, working on a team, will engage in creating PBSL activities for a selected course. Working in a group of four, each team will create their PBSL project activities. The approach to designing the actions for the PBSL project will be the Backward Design model (Jozwik et al, 2017). The Backward Design strategy guides the teacher to begin by stating the goals to be accomplished from the activity, followed by the learning outcomes intended to reach that goal, and the instructional objectives performed to ensure the learning outcomes and goals will are achieved. After completing the process and debriefing their experience, new teams are formed, and the process is repeated with a new group and a different course. The repetition of the process will give STEM instructors and increased self-efficacy in their ability to facilitate the project with their students successfully.

This activity is followed by free time to develop the participants' outline for their actions and receive feedback from fellow participants. In recent studies, social networking among faculty is reported as a convenient and useful tool to support PD innovations (McConnell, Montplaisir, & Offerdahl, 2019; Middleton et al., 2015). Creating a CoP is recognized as one tool to support persistence in faculty implementation of new methods (Engin & Atkinson, 2015; Liu, Miller, & Jahng, 2016; Shufeng, Herman, West, & Mest, 2019). The final discussion on the second day will include the cohort designing a support structure for a Cop for the successful implementation of the project. Reflective writing has been revealed as an important tool for improving teacher effectiveness (Kirpalani, 2017; Maddux & Donnett, 2015; Schon, 1987). Throughout the 2-day conference, time is allowed for reflective writing, sharing insights, paired-sharing, and peer feedback. John Dewey (1938) wrote that it is through written reflection that we learn.

Needed Resources

Caffarella and Daffron (2013) wrote about the importance of attention to detail when planning a successful conference. Required resources to be considered are suitable facility, location, meeting rooms, instructional equipment, overnight accommodations, marketing support, administrative assistance, financial funding, and participants to attend. The conference can be held at my institution. We have a faculty room in our library that is used for PD events. This room is also equipped with the technological equipment needed for presentations. We are located near a university that may be able to assist us with overnight accommodations. Otherwise, there is a motel adjacent to our campus. Potential barriers for faculty participation are funding for the applicants coming to the event and resistance of STEM faculty to attending. Studies suggested faculty seek recognition or financial reward for their participation in PD (Botham, 2018). One solution to this potential financial problem is to reach out to the Provost and share about the project and ask him to pay for faculty participation as an acknowledgment of their commitment to improving teacher effectiveness. Regarding STEM faculty attending the conference, I can reach out to the STEM Division Deans and Service Learning Directors on the campuses of the community colleges for their support for STEM faculty participation and ask them to partner with me in inviting faculty to join. Both groups will know instructors who might be interested in such a conference.

Implementation

Because the design is a 2-day conference (Appendices G and H), 1 year is suggested to adequately prepare and implement the conference (Caffarella & Daffron, 2013). The implementation of the PD conference is planned for June 2021. Having the event in June will give STEM faculty enough time to initiate their PBSL activities in the fall term of 2021. The follow-up gathering will take place in the spring of 2022.

My role in the conference is that I will be in charge of planning and marketing the event, registering faculty in the conference, enlisting support from department chairs, deans of STEM, college administrators, securing financial incentives and facilitating both days. Initially, I will meet with the Civic Engagement Director and Academic Provost at my college to share with them about my idea and secure their support and assistance. The civic engagement director will be a resource for information on what she has found works in producing a successful conference. She also has an available staff of people I will be able to call on for specific jobs during the planning and execution of the meeting. The academic provost can support the conference by networking with the chief academic officers in nearby community colleges asking them to support STEM faculty attending the conference and to provide a financial award for participating in the session.

I need to oversee the conference the first time through. I want to learn what structures are necessary for the conference to produce deliverables and be productive. I intend to understand what actions are essential to scale up the project so any of the STEM faculty who attended would be able to successfully reproduce this conference for another group of STEM faculty. Finally, expanding beyond STEM, my understanding of the critical components in the structure could be used to train other faulty to design PBSL activities for their classes and enhance students' perceived self-efficacy in various cognitive domains leading to higher rates of persistence and retention.

Project Evaluation Plan

Structured program evaluation is critical to determine if the design and delivery of the conference were valid and to what degree the stated learning outcomes were accomplished for the participants (Caffarella & Daffron, 2013). A summative assessment will focus on assessing the outcomes of the conference. Summative assessment will be determined using a Likert scale, which will be administered twice, once at the end of the meeting, and in the spring of 2022 at the completion gathering. Statements for the survey will emerge as the conference proceeds. A formative review will concentrate on what can be done to improve the content and delivery of the conference while it is in progress. This opportunity for feedback will allow participants to be partners in the delivery of the program and be invaluable for creating a practical design. The form of the formative assessment will be a handout that will ask participants to respond to several open-ended questions at the end of each day.

The goal of the proposed project is to create a cohort of STEM community college faculty trained in developing effectual project-based service-learning activities designed to enhance students' perceived self-efficacy in the cognitive domain of STEM subjects.

Conference outcomes:

- To have participants aware of the attrition, persistence, and retention statistics of STEM majors nationally and statewide
- To educate faculty on the distinction of self-efficacy and its impact on student persistence and retention
- Introduce the model of project-based service-learning as a pedagogical tool to increase perceived student self-efficacy in the cognitive domain of STEM courses
- Provide training in the development of effective PBSL activities for their STEM courses

The summative goal of the evaluation plan is to critically assess if the outcomes of the conference were achieved by the cohort. Did the structure of a PD conference and formation of a CoP provide adequate instruction and support for the members to achieve the goal of implementing the PBSL activities in their classes? In the formative assessment, I would like to know their experience of going through the conference and developing the PBSL activities. Which parts of the conference were most helpful, of little value, informative, etc.? This data will inform me on how to proceed successfully in future meetings on the dissemination of the findings of my research.

Key stakeholders within the institutions who would be interested in the evaluations from this conference are the Deans of the STEM Divisions of the participating schools. Student retention and persistence are always paramount in their concerns. Any program that is successfully attempting to forward student persistence in

STEM careers is of significant interest. Also, Academic Provosts are stakeholders. Being able to see the long view, results from the PD conference will enable chief academic officers to support additional PBSL activities at their institutions. Presidents of the participating colleges can be informed. These stakeholders are valuable to communicate to the community at large the work being done and engage with potentials partners in the future. Externally, community partners who are already part of the project would appreciate knowing about the results of the conference. This information can empower them to be more active partners for finding sites for service-learning activities. Announcements in local newspapers and on twitter feed inform interested parties of community colleges' endeavors to support STEM students' persistence and success. It is good press for the institutions and faculties, which can help a positive image in the community.

Project Implications

The PD conference on PBSL will create an informed cohort of STEM faculty on the statistics of STEM attrition locally and nationally, the concept of self-efficacy and, the effect of student perceived self-efficacy in student persistence and success. Finally, the group will be trained in how to facilitate productive PBSL activities that can enhance students' perceived self-efficacy in STEM disciplines.

The possible social implications of the PD conference would be a team of STEM faculty trained to facilitate PBSL activities for STEM courses. The implementation of more PBSL activities can generate more students confident that they can be successful

STEM students and STEM majors. The creation of more successful STEM majors with degrees will address a local and national problem of having enough STEM majors available for jobs in the STEM field. This group of trained faculties in self-efficacy and PBSL activities can return to their institutions and educate other STEM colleagues in the information learned at the PD conference and the pedagogical tools of PBSL. In other words, the gathering can be a seed to transform the experience of community college students into successful STEM majors.

The importance of the project to local stakeholders is that the PD conference provides much-needed PD for college faculty in STEM disciplines. Participants will be trained in effectively facilitating PBSL activities that may increase students' perceived self-efficacy and contribute to the retention and persistence of STEM majors. The project will also improve the implementation of PBSL, which is considered a high-impact pedagogical intervention (Bringle, 2017). This project may lead to a shift in the inclusion of PBSL undertakings in STEM as an intervention to impact student retention and persistence of STEM majors.

Section 4: Reflections and Conclusions

This doctoral research study was designed to explore General Chemistry college students' perceived self-efficacy after participating in PBSL activities. The local problem this study addressed was the low persistence and retention statistics of General Chemistry students in earning associate degrees as STEM students or transferring as STEM majors to a 4-year institution. Studies suggested that students perceived self-efficacy in the cognitive domain of a subject to support persistence and retention in college majors. PBSL has been identified as a pedagogical strategy that has the potential to use Bandura's category to be a *mastery experience* for participants. According to Bandura (1997), mastery experiences are occasions to increase students' perceived self-efficacy.

Project Strengths and Limitations

The strengths of the project include the design of the PD program, the content of the conference, training in designing PBSL activities for STEM courses (like my project study), and creating a network of resources for support. The design of the program is a 2-day in-person conference (see Appendix G) for STEM community college faculty across the state in the region of the country where the research was carried out. A 2-day rather than a 3-day conference was chosen, because lack of time was one of the reasons higher education faculty reported was a barrier to participating in PD conferences (Botham, 2018). Also, I believe a 2-day conference with a completion meeting at the end of the 2nd semester would be more useful than a third day of a conference. According to my review of the literature, faculty who engaged in PD activities were more aware of various teaching strategies and resulted in improving teaching skills. Online PD programs provide useful information and strategies for teaching and learning but cannot substitute for the value of face-to-face programs, which provide participants more opportunities for interaction, collaboration, and networking. However, with the present COVOD-19 pandemic, consideration of video conference might be more feasible at this time.

Another strength of the design of the program is the content covered in the conference. On the first day, the context for engaging in PBSL pedagogy is explored. This information will make clear the local and national situation about students completing as STEM majors and the reasons for why it is imperative as STEM educators to become involved in systematic interventions. The content of the first day will include Bandura's model of self-efficacy and his proposed experiences that enhance the individual's perceived self-efficacy. This model of enhanced self-efficacy will be proposed as one intervention to address the STEM attrition problem. I will also present a review of the literature on studies that suggested a connection between students' perceived self-efficacy in the cognitive domain and persistence and retention as college students and STEM majors and PBSL as a pedagogical activity that has the potential to provide a mastery experience for the student.

The specific model of the PBSL activities for General Chemistry participants used in the research study will be presented. This discussion is followed by student participants who will share on the impact of the PBSL activities on their self-efficacy (confidence) in chemistry and as STEM students and local stakeholders testimonials on the need and value for these types of activities in the local community. The discussion at dinner will center around possibilities and challenges for participants engaging in this project. The closing discussion will address the question, “If I choose to engage in this strategy, where do I begin”?

Day 2 is designed as a practicum to train participants in implementing the strategies of PBSL and creating a specific set of activities they could apply in one of their courses for a PBSL experience for their students. Everyone will be given time to receive formative feedback on the design they have created. This training will empower the perceived self-efficacy of STEM faculty to facilitate effective PBSL activities. Enhanced self-efficacy in creating the PBSL activities will make a difference in their students’ perceived self-efficacy. The ultimate strength of the PD conference is the formation of a CoP to inquire, share, and support each other in realizing a successful and sustaining project-based service-learning pedagogy for STEM students at their college.

There are several limitations to the design of the PD conference that implements the research findings. These challenges include the small number of faculty participating in the project, lack of incentive and support to do the project in their home institution, lack of support, and the challenges of sustaining the activities over time. Given the magnitude of the problem of the attrition rate of STEM majors, this format initially will not reach a large population of STEM faculty trained in the pedagogy of PBSL and might lead to an insignificant positive social change. Additionally, in the current design of the PD conference, there is no added incentive for participants to do PBSL activities after they leave the meeting. There is no course release or stipend to complete a PBSL activities in one of their STEM courses. Botham (2018) wrote that lack of time was one of the most reported reasons for lack of faculty participation in PD programs. The first time introducing an intervention frequently requires additional time and energy to bring the plan into existence. Community college instructors regularly teach five courses, which does not leave much time for further PD preparation for new pedagogical strategies.

Also, PBSL activities require support from local partners and approval of the dean of the department. Participants may leave the conference and have limited support to enact these pedagogical strategies in their home institution. Institutional and community partner support for service-learning activities are critical for a successful program. Finally, although a CoP created at the conference provides a support structure, keeping CoP’s in existence over time requires time and attention.

Alternative Definitions of the Problem

Lack of self-efficacy is the assumption in this study for students' lack of persistence as STEM majors. In my review of the literature, several research studies suggested other definitions of the problem of retention of community college students. In a survey of 4000 community college students, where 700 students responded, the cost of education, lack of motivation, work schedule, and family concerns were reported as the main factors affecting student retention (Mertes & Jankoviak, 2016). In another study that interviewed community college students, faculty, and administrators. Lacking social capital and being academically underprepared were suggested for the lack of community college students' persistence and retention (Martin, Galentino, and Townsend, 2014). Finally, Stuart, Rios-Aguillar, and Deil-Amen (2014) proposed a theoretical model that related student persistence in a community college with the job market and the cost-effectiveness of an education-related to available employment. These alternative definitions of the problem could be applied to the lack of retention of STEM majors.

In a study of STEM majors, three factors were suggested as the reason for student attrition in STEM: the challenging nature of STEM courses, lower GPAs than general education courses, and students who delayed to take classes in their STEM major (Chen, 2015). Regarding Stem majors persistence, one study suggested innate student interest in STEM was a factor (Maltese, Melki, and Wiebke, 2014), while research by Le, Robins, and Westrick (2014) reported that academic ability and interest were meaningful influences for student choice and persistence in STEM.

Alternate Solutions to the Problem

One alternative solution to the local problem of retention of STEM majors could be in the form of a peer-led tutoring program for STEM majors in gateway courses. This approach was reviewed in a study by Kling and Salomone (215). Students participating in this program had fewer DFW grades, an increase in A and B grades, and overall two-year STEM retention higher compared to other years. Another approach was through an NSF scholarship program, at a diverse college setting, offered financial rewards to recruit and retain physical science and mathematics majors (Chang, Kwon, Stevens, Buonora, 2016). In addition to financial assistance, the program provided structured activities, faculty mentoring, advising during critical periods, and community building through cohorts. All the participants (44) continued to graduate in STEM. Finally, a report by ISSE educators on a 14-year mentoring program had an average 81% persistence completion result for underrepresented minorities and women in STEM majors (Meteview, Seagroves, Shaw & Hunter, 2015). This intervention had an intensive training of mentors to prepare them for working with students. In reviewing the literature on persistence and retention of college chemistry students, I discovered two studies. One project used the peer-tutor model where the peer-tutor was assigned to the lab period and to run a peer-led study session (Damkaci, Braun, Gublo,2017). The other study used a team-based learning model for first-semester General Chemistry students (Comeford, 2016). Students read the material at home and took a quiz. During class, the instructor gave a short lecture from the instructor and then in assigned groups work on a problem set in the class. The attrition is the team-based learning courses were much lower than the comparable General Chemistry sections.

The local problem addressed in this project study was the low rate of persistence as STEM majors of students at a community college in the northeast of the United States. Participation in PBSL activities by General Chemistry college students was studied to see the impact on the students' perceived self-efficacy in chemistry. Enhanced self-efficacy in the cognitive domain of chemistry was suggested as a strategy to increase student persistence in chemistry. General Chemistry is a gateway course for most STEM majors.

Success in chemistry supports the student continuing to further their studies as STEM students. General Chemistry college students' participating in project-based service-learning activities were investigated to learn about students' perceived self-efficacy in chemistry.

Alternate Approaches to Disseminate the Findings

I chose a PD 2-day conference of faculty members in the community colleges in the home-state of the project study to share the findings of my research and to train faculty to implement practical PBSL activities for their STEM courses. Three alternative approaches that could be used to share the research findings to promote a positive social change would be to develop a resource manual for STEM college faculty interested in introducing PBSL activities in their courses, submitting an article which shares the research of the study to a peer-reviewed journal, or submitting a proposal to lead a symposium, on the findings of the study, to a national chemistry or STEM conference. Wengerd (2009) developed a resource manual on PBSL activities for first-grade mathematics teachers. She believed that this format could promote positive social change because the manual could support teachers to provide for the needs of their capable students. A manual would be available over time and potentially can reach a much wider audience than a 2-day conference. However, Wengerd wrote of her concerns about teachers using the manual in their classes. She felt this approach was a limitation of this strategy to share her findings. Some questions to consider are who would the resource manual be distributed to for use? Would there be any training in how to design productive PBSL activities for STEM courses? At least with the 2-day conference, there would be a cohort of STEM faculty trained to develop PBSL activities. This group of educators could bring back the information to their respective institutions and help others to implement PBSL in their courses.

Writing a peer-reviewed scholarly article that presented the basics of the project study and the findings would be another alternative approach to promote a positive social change. This paper would provide an audience on a large scale who could review the research and provide feedback for further endeavors in this area and try out PBSL activities with their students. It also expands the viewers to fields outside of STEM, which allows faculty in other disciplines to use the data in their courses. Given there is limited literature on PBSL research and science courses, this alternative approach to sharing the findings could provide an increase in positive social change by adding knowledge to the subject of PBSL for STEM courses. One limit to this tactic is the general nature of the design of the method. How many faculty members would feel the confidence to engage in these activities without some training? Would it become one more good idea that did not get executed?

Facilitating a session or symposium on project-based service-learning in chemistry at a national chemistry or STEM conference would promote a positive social change. This approach would reach a broad audience of STEM faculty and be advertised through the marketing of the meeting. A breakout session at a conference could deliver the basics of the research and glean the interest and challenges instructors may have in being trained to implement PBSL activities in their courses. If there were enough interest in PBSL for STEM students generated in the breakout session, a conference could be planned for a future date. A symposium would be like the 2-day PD conference in that it would include the essential findings of my research and time to train participants in developing practical PBSL projects to increase the self-efficacy of their students in STEM. Limitations of the seminar format is a lack of significant support structure for participants, after the symposium, to design successful PBSL activities for their courses.

Scholarship, Project Development, and Leadership and Change

What I learned from doing my doctoral research study was a comprehensive understanding and value of scholarship as an educator. I learned that scholarship is concerned with the integrity of inquiry and reporting of information to an audience of interested people. I learned that scholarship is related to rigor in the review of the literature on the topic you are investigating. Using a qualitative research method for my study, I learned the importance of scholarly research of saturating my review of the literature both in-depth and scope using recently published articles. Engagement in the scholarship of learning is the method of a researcher.

The exploration is approached with an open mind, willing to be receptive to challenges to your thinking and beliefs; it also involves rigorous thinking and analysis. I learned to support ideas with scholarly sources and to defend my research based on evidence rather than opinion. Scholarship takes time, a willingness to keep rewriting until the document accurately reflects your findings and what you want to communicate.

Scholarship also embraces a willingness to not be satisfied with the research, but to always keep looking to uncover new ideas and explanations for problems.

The practice of scholarship is empowering, creative, and exciting - to have learned the skills of what it takes to be a researcher and confident in your ability to be one is energizing and rewarding. One of my favorite Einstein quotes, "Education is what remains after one has forgotten what one has learned in school.", also relates to my experience of learning to be a scholar. All the course work and project study at Walden was to create me as a scholar, a Doctor of Education.

To have an Ed.D. is to be recognized as a scholar in the field of education. It is who I am after I have forgotten what I learned at Walden. I can honestly say that the goal of being a scholar, a research practitioner, is fulfilled for me. I now relate to myself as someone who has the knowledge, skills, and mindset to address educational challenges with a scholarly approach and attitude. The initial reason I sought a doctoral degree in education was to learn the social science research skills needed to explore the impact of PBSL activities on my chemistry students. I have accomplished that goal.

I learned that scholarship applies to all areas of educational undertakings. I had no idea of all the elements required to create a successful PD project. Initially, the idea of doing a literature review on types of PD projects seemed unnecessary. When I finally surrendered and performed the literature review, as outlined in the Walden rubric, I learned so much about PD programs and the research done on their effectiveness. This information altered the design of the PD conference I created. The same scholarly principles of rigorous thinking, searching the literature for recent research on the topic, willingness to be informed by the literature apply to the PD conference as well as the PBSL activities. I learned that scholarship is an approach to doing credible research and creating a positive social change in the STEM education field. The practice of a scholarly approach to research increases my confidence as a reliable practitioner.

Reflective Analysis of Personal Learning and Growth as a Scholar

Before my doctoral journey, I had a general idea of an academic scholar. For the last 15 years, I have been a part of our faculty Scholarship of Teaching and Learning community at my college. For the most recent eight years, I have co-coordinated the Scholarship of Teaching and Learning group at my college with a colleague. We have engaged in many action-research projects. Currently, we are working on a 100% course completion project in our classes. Interestingly, my first Scholarship of Teaching and Learning action-research project, 15 years ago, was exploring PBSL and student engagement.

I have learned what it means to be a scholar and to take a scholarly approach to problem-solving. When I was engaging in action-research projects in Scholarship of Teaching and Learning, I lacked the rigor and skills required for academic research. I have learned what is necessary to have a credible literature review and how to design a study that aligns a local problem with a purpose of a project study, research questions, tools for collecting data, data points, and analysis of data. Through guidance and feedback from Walden faculty and my dissertation committee members, I learned that as a scholar, research is an iterative process. I learned there is always room for editing my writing. I also learned that there are no short-cuts when I am a scholar. My work is in the world of my peers to evaluate, give feedback on areas for improvement, or present challenges to the analysis of my findings. I have learned that to be a scholar, there were tools I needed and did not have. The process of my doctoral journey has given me the tools and mindset of a scholar, a Doctor of Education. I am proud and pleased with the work I have done and what I have learned in the process.

Reflective Analysis of Learning and Growth as a Practitioner

I have been a successful high school chemistry teacher and college instructor. My love for teaching, my students, and chemistry has empowered me to seek the best way to teach chemistry and empower my students. According to the Miriam Webster dictionary, a practitioner is one who practices, especially a professional (https://www.merriam-webster.com/dictionary/). I never really thought of myself as a practitioner in education. This description and my experience in my doctoral program reveal to me that my teaching is a practice that is alive and creative. I have learned how to be a scholarly practitioner in research and project development during my Walden experience.

The most significant difference in being an academic-practitioner is the approach I now take to addressing problems. Today, one of my first actions is to review the literature on the issue I would like to investigate. This process of reviewing the literature includes reviewing recent and seminal scholarly resources for data on the problem, possible interventions, or strategies to effect change. This information informs my research question(s), research method, tools for collecting data. As a researcher, my work is informed by the work of other scholars. I also have an intention that what I learn contributes to the knowledge base in my research. For this reason, I have learned the importance of academic integrity in all aspects of my research. Anyone who reviews my research, as scholarly work, depends on the information I present to be credible and reliable.

Reflective Analysis of Learning and Growth as a Project Developer

In developing a PD conference, I learned that as an academic-practitioner, the design of the meeting should reflect a critical review of the literature. This analysis of the current scholarly research on PD helped me to determine which professional design was most effective for the outcomes I was committed to achieving in the conference. Studies done with faculty on their PD experiences guided me in setting the length of the meeting, the need for a community of practice, and a follow-up strategy to support participants. Before beginning my doctoral studies, I would have designed a workshop based on my good ideas and opinions about what I thought would be successful. I am sure there would have been some degree of effectiveness of the conference, but this tactic would lack the rigor and efficacy of a scholarly approach provided.

Reflective Analysis of Learning and Growth as a Leader and Change Agent

The growth I have experienced in my doctoral education is in a higher degree of confidence in my ability to be a leader and a change agent. Before I began my doctoral journey, I would assess that the faculty and administration of my institution related to me as a leader on many levels, including teaching, introducing new pedagogy, and facilitating colleagues in action research projects at the college. In learning to be a research scholar, I have grown in approaching problems with the mindset of an investigator. I review the scholarly literature on the issue and glean the type of interventions tried and the findings of these studies.

This data informs my actions as I approach the situation. I inquire into possible solutions to the problem rather than thinking that my answer is the "right" one. Today, I have tools to speak confidently and the willingness to offer suggestions for change that may not be popular at that moment. I am also listened to and respected by faculty and staff as an academic scholar who can be trusted to be honest and rigorous in pursuing solutions to institutional problems. In the last two years, my Scholarship of Teaching and Learning colleague and I were given the responsibility for designing the professional development of the faculty at our institution. My growth as a leader and change agent was partly responsible for this new accountability.

Reflection on the Importance of the Work

The project study was a scholarly research exploration on a persistent problem both nationally and at my institution - the low rate of persistence of declared STEM majors in their field. The study focused on the perceived self-efficacy of STEM majors after participating in PBSL activities in general chemistry. Studies suggested that students' perceived self-efficacy is related to persistence for STEM majors in their field. No research had been done at my institution regarding interventions that might be used to support STEM students persisting in their academic fields. The research was also useful because it connected students' perceived self-efficacy with a widely recognized high-impact pedagogy PBSL. The PD conference, created to promote social change, is vital because it will provide useful information on the seriousness of the problem of retention of STEM majors in higher education. The training on the implementation of PBSL activities for college STEM courses has the potential to enhance the expertise of participating faculty in engaging in these effective pedagogical strategies.

The work contributed to the knowledgebase regarding PBSL activities in college chemistry as a possible pedagogical strategy to enhance students' perceived self-efficacy in the cognitive domain of chemistry. This hopefully can support increased retention of STEM majors. Using PBSL as a strategy to increase student perceived self-efficacy and support student retention as STEM majors is an innovative solution to a persistent problem.

For the comprehensive review of recent scholarly literature for my research, I searched using the following keywords: self-efficacy and student persistence and success; self-efficacy, student persistence and success in STEM; self-efficacy and student persistence, and success in chemistry contribute to the knowledge-base on the connection between self-efficacy and persistence for college students. Likewise, the review of recent literature on SL and PBSL as a pedagogical strategy to enhance students’ perceived self-efficacy is critical because it informs the academic community in a coherent listing to the possible connection between self-efficacy, PBSL, and an increase of STEM graduates in the workforce. Finally, in challenging financial times, PBSL is a pedagogical strategy they can implement at minimal cost to the institution.

Implications, Applications, and Directions for Future Research

One potential impact for positive social change of the research into General Chemistry college students' perceived self-efficacy after completing PBSL activities is in STEM majors persisting and earning a degree in a STEM field. One positive social change that can occur is more students graduating in STEM and entering the workforce as STEM employees. Also, increasing the workforce will reduce the number of STEM majors with unfulfilled aspirations of being scientists and engineers. They can be models for members of their family and other students that they can persist and be successful in the challenges of a STEM major. Individually, these students will have a higher degree of self-efficacy in the cognitive domain of STEM subjects, which will make them more confident and creative members of the workforce, able to work effectively in teams, and assume leadership roles at their jobs.

They will bring leadership skills to their ability to create a research project, work with groups to develop plans, and contribute what they know to the project. Having participated in PBSL activities in Chemistry, as STEM graduates, they will be engaged in their community as STEM contributors and mentors. Several of the college chemistry students who participated in the research expressed an interest in future opportunities to participate in service learning. These students can be essential stakeholders in the community as STEM graduates and employees.

Methodological Implications

This project study was exploratory. I chose a qualitative methods approach because I was interested in the life experiences of the students doing the project. A quantitative research approach would not have provided with the rich descriptive data that qualitative inquiries provide. It was recommended by my research methods professor to use one-to-one interviews rather than focus groups. I think that was an excellent choice. Each student who was interviewed had the same set of questions. They were able to express their answers to each question individually. This methodological approach provided me with a rich body of data to code for emerging themes. The coded themes presented research findings that allowed me to understand, from their perspective, the impact of the PBSL activities on them as Chemistry students and STEM majors.

Theoretical Implications

When I started my study, I was not familiar with the theoretical concept of self-efficacy as a strategy to support student persistence and retention. When I began my research, I focused on student persistence and retention of STEM majors and PBSL as a pedagogical tool to support retention and persistence. As I reviewed the literature on studies on persistence and retention of college students and STEM majors, I learned about findings that suggested students' perceived self-efficacy was a critical factor in their success. Bandura's (1997) theory of self-efficacy and learning proposed four accesses to increase self-efficacy (mastery experience, verbal persuasion, virtual experience, emotional state). I believed that PBSL was a pedagogical strategy that had the potential to be a mastery experience for the students. Findings from my research suggested that General Chemistry college students' participation in the PBSL activities increased their perceived self-efficacy in the cognitive domain of chemistry and as STEM majors.

These findings imply that PBSL activities in STEM may provide the potential to increase persistence and retention of STEM majors. PBSL is a pedagogical strategy that has no overhead, allows all the students in the class to participate, and easily adapted to a community college structure of lab instruction. With proper preparation and mentoring, faculty who are interested can learn how to design PBSL activities that have the potential to provide a mastery experience as STEM majors, as outlined by Bandura.

Recommendations for Future Research

This research was exploratory and consisted of a small sample population. Many opportunities for future research evolved from this project study. First, the data from a larger random population sample would be more meaningful. A mixed-methods study would be ideal because this approach would include both quantitative and qualitative data. This methodology would give a summative and formative picture of the students' perceived self-efficacy in a STEM subject and as STEM majors. Another recommendation for future research is a longitudinal study tracking the persistence and retention as STEM majors of the college students who participated in the PBSL activities. The degree of success of PBSL students might provide some long-term insights into the effectiveness of the PBSL for the persistence and success of STEM majors.

Recommendations for Practice

Persistence and Retention of STEM majors is a local problem at my institution and nationally. From the findings of my research, PBSL activities for STEM majors is a pedagogical strategy that has the potential to support persistence and retention in their STEM fields. Expanding the number of PBSL projects in community colleges for STEM majors could be an initiative that could make a difference in persistence and retention. However, STEM faculty need to be introduced to the methodology of PBSL and be trained. Their instruction should include designing productive PBSL activities where one of the learning outcomes is to enhance students' perceived self-efficacy in the cognitive domain of a STEM discipline. PD for faculty is key to the effectiveness of this approach.

Conclusion

The findings of the project study suggested that PBSL, as a pedagogical strategy increases students' perceived self-efficacy in the cognitive domain of chemistry. Increased chemical knowledge, working with the kids, working on a team, and overall participation in the PBSL activities, students reported as factors that supported their experience of increased self-efficacy in the domain of chemistry and as STEM majors. The findings of the research suggested that students participating in PBSL activities might increase student persistence and retention as STEM majors. A 2-day PD conference was developed to create a cohort of STEM community-college faculty CoP trained in developing project-based service-learning activities designed to enhance students' perceived self-efficacy in the cognitive domain of STEM subjects.

The importance of the work was that it was a scholarly research study on a persistent problem both nationally and at my institution: the low rate of persistence of General Chemistry students and declared STEM majors. Overall, the work contributed to the knowledge base regarding PBSL activities in college chemistry as a possible pedagogical strategy to enhance students' perceived self-efficacy in the cognitive domain of chemistry and possibly support increased retention of STEM majors. In challenging financial times, PBSL is a pedagogical strategy that institutions can implement at a minimal cost.

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Appendix A: Form for Demographic Information

Dear Student:

The following information is requested to ensure a diverse sample of participants for the research study. The information will be kept confidential, and no names will be disclosed in the research.

Please return this form with your signed Informed Consent.

Sarah Quast Sliker
Researcher

Please provide the following information:

Name ______________________________

Birthdate: _______________

Cultural identification (Place an **X** in the appropriate box):

Black___, Latino___, Native American___, Southeast Asian ___, Other ____.

STEM Major: _______________________

Gender: (Place an **X** in the appropriate box) male _____; female _____

Appendix B: Interview Questions

1. Have you ever participated in a service-learning project before?

2. How has your understanding of chemistry changed after completing the SL project?

3. How have you changed as a chemistry student after participating in this project?

4. How did the experience of working on the SL project affect your confidence as a chemistry student?

5. How did the experience of interacting with your team affect your confidence as a chemistry student?

6. How did the experience of working with the elementary school students affect your confidence as a chemistry student?

7. What about your participation affected your confidence as a chemistry student?

8. What did you learn about yourself as a chemistry student?

9. How did participating in the SL activity support you as a chemistry student?

10. What was your most memorable experience participating in this project?

11. As we come to an end, would you like to add anything else that we missed?

Appendix C: Reflective-Journal Questions

1. After reading the student reflections of the three students who participated in service-learning, what do you think service-learning is about?

2. After your preparation for the lab experience for the kids, write your thoughts about doing the project.

3. After meeting with your team to discuss your project, write a reflection on your thoughts about participating in the project-based service-learning project.

4. Write a reflection of your experience, having just completed the project.

5. What about your participation affected your confidence as a chemistry student?

6. What did you learn about yourself as a chemistry student?

7. How did participating in the service-learning activities support you as a chemistry student?

8. What was your most memorable experience participating in this project?

9. Anything else you want to share about your experience doing this project?

Appendix D: Professional Development Project PowerPoint Presentation Day 1

8:30 – 9:00 am	Registration, Continental Breakfast, Conversation
9:00 – 9:15 am	Welcome: President and Provost of the College
9:15 – 9:30 am	Review of Goals and Learning Outcomes for the Conference
9:30 – 10:00 am	Icebreaker – Getting to Know You: Who is Here; Why you Came
10:00 – 10:20 am	My Story about Project-Based Service-Learning
10:20 – 10:40 am	Break
10:40 – 11:30 am	Session 1: Facts about STEM Majors persistence and completion
11:30 – 12:30 pm	Lunch
12:30 – 1:30 pm	Session 2: Increasing Student Self-Efficacy – one solution to address the STEM attrition problem
1:30 – 1:45 pm	Break and assignment
1:45 – 2:45 pm	Discussion - Project-based Service Learning as a Pedagogical tool for increasing Student Self-efficacy in STEM disciplines
2:45 – 3:00 pm	Break and Assignment
3:00 – 4:00 pm	Model: Project-based Service-Learning activities for General Chemistry Students
4:00 – 4:30 pm	Testimonials: Chemistry students, local stakeholders
5:30 – 6:30 pm	Dinner and Assignment – possibilities and challenges for doing the project
6:30 – 7:30 pm	Discussion: Where to Begin?
7:30 pm	Completion – Assignment

Project-based Service-Learning Conference

Supporting Persistence and Retention of STEM majors

Sarah Sliker

Walden University

Goals for the Conference

- You will feel confident in facilitating project-based service-learning activities in your courses to promote the persistence and retention of your students.
- You will experience creating a Community of Practice for project-based service-learning

Learning Outcomes – Day 1

As a result of participating in Day 1, you will be able to

- Discuss the findings on retention and persistence of STEM majors as a national and local problem
- Explain the conceptual model of self-efficacy
- Identify the four conditions that lead to enhanced self-efficacy for an individual
- Contrast the structures of service-learning (SL), project-based learning (PBL), and project-based service-learning (PBSL)
- Distinguish the qualities of PBSL that support increased SE
- Identify possibilities and challenges in developing PBSL activities at your college

Ice Breaker – *Getting to Know You!*

Introductions:

- Name, College, Discipline
- Why you chose to come to the conference
- What you would like to accomplish by attending this conference
- Share one of your interests or passions (besides teaching!) that you would like us to know about you

Creating a Community of Practice (CoP) – An Inquiry/Discussion

- ***What is a community of practice?***

  - CoPs are a group of people defined by their common interest in a domain of knowledge, such as teaching (Wenger, McDermott, & Snyder, 2002).

- **What is the value of being part of a community of practice?**

  - CoPs can provide a supportive environment that challenges instructors' counterproductive beliefs about effective instruction while also spreading knowledge about evidence-based instructional practices (EBIP) and the beliefs that support them (Kezar, Gehrke, & Bernstein-Sierra, 2017).

Creating a Community of Practice (CoP) – An Inquiry/Discussion

What are the components that are necessary to create a CoP?

- The community is characterized by joint activities and discussions that share information and help members learn from each other (Wenger et.al, 2002).

- CoPs can span organizations, particularly through the creation of online or virtual communities of practice (Kezar, et. al, 2017).

My Story

- Participated in a Service-Learning Institute AY 2005-2006
- Two of my passions are service and advancing women in science
- Created a project-based service-learning project with my chemistry students and girls from a local girls' club
- The project had the girls come into the chemistry lab and do a chemistry experiment mentored by my chemistry students
- The project was a huge success with my students
- The project has continued every semester for the last 14 years
- My doctoral research is on the impact of this project on my students' perceived SE in the domain of chemistry and as STEM majors

National Problem

- Six-year study indicated that 48% of baccalaureate and 69% of associate degree students left the STEM field before they completed their degree (Chen, 2015)
- Underrepresented Minorities (URM) and women had significantly lower STEM graduate levels than White males (Mau, 2016)
- President's Council of Advisors on Science and Technology (PCAST) report forecasted one million STEM jobs would not be filled due to a lack of graduating STEM majors in the United States (PCAST, 2012)
- A place to begin to address this crisis is to increase the persistence of the STEM students we already have enrolled in our institutions (PCAST, 2012; Chen & Soldner, 2013)

Local Problem

- Sixty percent of STEM majors do not earn associate degrees in STEM or transfer as STEM majors to a 4-year institution (Institutional statistics, June 11, 2016)
- A local division in a regional state agency, STEM Occupation Projections (STEMOP), projected an increase in most STEM occupations in the region
- Thirty-nine percent of students enrolled in General Chemistry who identified themselves as STEM majors completed an associate degree or qualified for transfer to a four-year institution (Institutional statistics, June 11, 2016).

Self-Efficacy- One Solution to the STEM Attrition Problem

- ***Perceived Self-efficacy:*** Bandura (1997) stated that self-efficacy refers to perceptions about one's capabilities to organize and implement actions necessary to attain the designated performance of skill for specific tasks.
- The essence of the theory is that it is one's belief in one's ability to be successful in performing a task that determines to a high degree if the individual will be successful.
- Bandura identified four experiences as being the primary sources of an individuals' self-efficacy: *enactive mastery experience (mastery experience), vicarious experience, verbal persuasion, and physiological and affective states*.

Access to Enhancing Self-Efficacy (Cox, 2005)

- Mastery experience - experience of having successfully achieved a challenging goal
- Vicarious experience - having the experience that you can accomplish a task by observing someone else performing the task
- Verbal persuasion – when an individual or group tells you that you have the ability to accomplish a task
- Emotive state – positive or negative emotional state influences self-efficacy

Self-efficacy and Student Success

- STEM student levels of SE were related to a higher level of *intrinsic* motivation and positive achievement (Simon et al., 2015)
- Vicarious experience, and social persuasion were as crucial as mastery experience in enhancing the participants' perceived self-efficacy for engineering students (Amelink et al., 2015)
- Self-efficacy and the students' interest in the subject matter were an essential incentive for their academic commitment to be successful (Vogel & Human-Vogel, 2016)
- Higher student SE in chemistry, the more likely they would continue to the second year of chemistry (Dalgety & Coll, 2006)

Academic Service-Learning, Project-Based Service Learning, Project-Based Learning

- Academic service-learning is defined as "a teaching and learning strategy that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities" (National Service-Learning Clearinghouse, 2011, p. 1).
- Project-based service-learning fulfills all the goals listed above but has a designed architecture to have the participants working as part of a team on the activity.
- Project-based learning is a student-centered model that organizes learning around engaging in projects. Service is not a component of the design (Du & Han, 2016).

SL and Student Success

- College students who participated in the SL project had higher lab quizzes and 85% reported a deeper understanding of the academic material (Saitta, Bowdon, & Geiger, 2011).
- Findings indicated a strong relationship between SL and participants' personal growth and sense of SE (Sanders, Oss, & McGeary, 2016).
- Participation in service-learning results in statistically significant student achievement as measured by student grades (Braill, 2016).

SL and SE

- Limited information on recent projects studying service-learning and its impact on the perceived self-efficacy of the participant
- A research study indicated a strong relationship between SL and participants' personal growth and sense of SE (Sanders, et. al, 2016).
- In a SL project, perceived SE decreased in a research study with 1st year honors students of both genders (Stewart and Alrutz, 2014).

Research Study – PBSL Project for General Chemistry Students

- Students are randomly placed in groups of four
- Each member of the group is assigned a role: team manager, experiment coordinator, lab-safety coordinator, presentation manager
- Each team creates goals, learning outcomes, and instructional objectives for the project
- Each group designs and implements a laboratory experience aligned with their goals, learning outcomes, and instructional objectives
- Working together in a team, students design the class and prepare all the materials needed to complete their project. i.e. lab safety, procedure, data tables, assessment

Testimonials

- Testimonials from students who participated in PBSL activities will share their experience doing the project and the value they have received as STEM majors from their participation in the project.
- Community stakeholders who have been partners in PBSL projects in the community for several years. Community stakeholders will attest to the need for such a project in their elementary, middle schools and youth organizations
- The endorsements will create a context for the value and need of PBSL activities for the community.

Possibilities, Challenges, Where to Begin?

- Paired and group sharing – What do you see are the possibilities from engaging in PBSL activities with your students?
- Paired and group sharing - What do you see may be some challenges in engaging in PBSL activities with your students?
- Aside from tomorrow's training on doing PBSL, what are the NEXT actions for you to take? Paired and group sharing.

Close and Assignment-Day 1

- Sharing – What would you like to share to complete Day 1?
- Discussion – Change causes upset
  -PBSL is a change from how you have been engaging your students
  -Wherever you are about doing PBSL it is fine
  -Make sure you come back tomorrow!
  -See me at the end of the session, with any concerns
- Assignment for tonight
  -Before we begin tomorrow morning, speak with at least two other participants about which course you might try out PBSL or what community stakeholders you may reach out for partnership?

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Appendix E: Professional Development Project PowerPoint Presentation Day 2

8:30 – 9:00 am	Continental Breakfast, Collegial Conversation
9:00 – 9:15 am	Review Today's Agenda
9:15 – 10:00 am	Sharing: Insights from Day 1 of the conference – individual and Twitter
10:00 – 11:15 am	Session 1: Develop a PBSL project in one discipline
11:15 – 11:35 am	Break and Assignment
11:35 – 12:45 pm	Session 2: Develop a PBSL project in one discipline with a new team
12:45 – 1:45 pm	Lunch
1:45 – 2:15 pm	Sharing: Insights from Morning Sessions – individual and Twitter
2:15 – 3:15 pm	Session 3: Work out details about your PBSL activities
3:15 – 3:30 pm	Break
3:30 – 4:30 pm	Feedback on your PBSL activities (in groups of 3)
4:30 – 5:00 pm	Discussion: Structure for Support – Options (video conferencing, face-to-face meeting in fall and spring, etc.)
5:00 – 5:15 pm	Wrap-up

Day 2 - Project-based Service-Learning Conference: Supporting Persistence and Retention of STEM majors

- Welcome to Day 2!
- Review today's agenda
- Group Sharing
  -Homework assignment
  -What you are learning about the problem of STEM retention, self-efficacy, service learning, project-based service-learning, community of practice
- Reflective Writing – Take a few minutes to jot down what you are learning about PBSL in the conference

Creating a PBSL Project

- Secure a community partner i.e., elementary school, high school, local girls' or boys' club, girl scouts or boy scouts, etc.
- If your college has a community engagement office, make a request for their support in finding a community partner
- Meet with your potential community partner. Share about the project and see if what you are proposing is in alignment with the needs of their school or organization
- Participants for the PBSL should be kids who are interested in science and their participation is voluntary.
- Let them know the project will take about 1.5 hours of time

Develop PBSL Activities for a Course

- Teams of four with the same discipline
- Choose a *team leader*, *lab safety officer*, *experiment coordinator*, and *presentation manager*
- Select goals, learning objectives, and instructional objectives you want to accomplish with this project
- Design PBSL activities that will accomplish the goals, learning outcomes, and instructional objectives you have established

Components of the PBSL Project

- Students are randomly assigned to a team
- Using the POGIL (POGIL, n.d.) structure for groups, each member has an assigned responsibility
- Students create goals, learning outcomes, instructional objectives for the project relative to the participants attending the event
- Students' design an experiment and activities that align with the goals, learning outcomes, and instructional objectives they have agreed on
- Reflective journals are used throughout the project for students to reflect on their experience and what they are learning

Creating a Team

- **Team leader -** job is to make sure the team works together to be fully ready for the project.
- **Lab safety officer -** responsible that correct laboratory safety procedures are followed during the activities. Instructs the participants in proper lab attire and procedures
- **Experiment Coordinator** – responsible to make the lab request for the chemicals, solutions, equipment, etc. in the proper amounts for the experiment.
- **Presentation Manager** – works with the team leader and is responsible to coordinate and manage the flow of all the activities before and during the project

Goals for the Project

- What goals do you have for the students in doing this project?
- What experience would you like them to leave with after spending time with you in the lab (chemistry, biology, physics, engineering)?
- What do you want them to share about their experience of participating in the project
- Write down three or four goals for your team for the project.

Student Learning Outcomes (SLOs)

- A student learning outcome is the action you want the participants to be able to do as a result of the activities.
- For example, the students should be able to:
  -explain in their own words the arrangement of the periodic table.
  -State two important lab safety rules
  -Make simple measurements of mass and volume and record them accurately on a data sheet
- Write four or five SLOs for your project.

Instructional Objectives

- An instructional objective is the **activity** that you will have the participant engage in to achieve the student learning outcomes you have chosen.
- For example,
  -participants will record their observations after mixing the chemicals
  -participants will accurately measure and record the mass and volume of a substance
- Write at least four instructional objectives for the SLOs you have chosen.

Choosing an Experiment

- Guidelines for the experiment (for students):
- The experiment must be one that you have done this semester in lab. You can design your experiment by choosing parts of different experiments.
- It should be an experiment that you enjoyed doing
- You need to decide what equipment, chemicals, amounts, waste, etc. you will need for the activities.
- The experiment should be designed for the age group that will be participating, including choice of experiments, procedure, data, etc.

Some Things to Think About

- Procedure for experiment.
- Data table to write down information
- Lab safety procedures
- Waste disposal
- How are you planning on presenting the topic?
- Division of jobs during the experiment. i.e. lab safety, who is going to present the topic, help with measurements, help with recording data, etc.
- How will you determine (assess) if the participants accomplished the goals, outcomes, and objectives that you set up?

Reflective Writing/Repeat the Exercise with a different course

- Take some time to write down notes on what you are learning about designing PBSL activities

- Paired-sharing
- Group sharing

- With **another team**, choose another course and develop the PBSL activities following the same template as the first course you chose

Lunch

- Lunch Assignment
  -Discuss strategies for course selection, community partners, and PBSL activities for your students

- After-lunch
  Group sharing
  Reflective writing on what you are discovering

Outline your PBSL Project and Share with your Triad

- Time for you to get specific on the details of your PBSL project for your students at your school, i.e., which course, when the event will occur, who are possible community partners, opportunities and challenges you may encounter
- In groups of three, take turns sharing your PBSL strategy and receive feedback and coaching from your colleagues. Begin your turn by sharing what excites you about doing the project with your students and your community.
- General sharing/reflection on insights from the exercise

Structure for Ongoing Support and Wrap-up

- Structure for Support
  -In your group of three, discuss what you need to be supported in implementing the project and making it successful.
  -Each group report out the main points of your discussion
  -Select a team leader for your CoP.
  -New CoP leader facilitate a discussion to create a structure to support your CoP
- Discussion on what to expect after you leave the conference and return to your campus