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Virtual school teacher's science efficacy beliefs: the effects of community of practice on science-teaching efficacy beliefs

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VIRTUAL SCHOOL TEACHER'S SCIENCE EFFICACY BELIEFS: THE EFFECTS OF COMMUNITY OF PRACTICE ON SCIENCE-TEACHING EFFICACY BELIEFS

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ABSTRACT

The purpose of this study was to examine how much K–12 science teachers working in a virtual school experience a community of practice and how that experience affects personal science-teaching efficacy and science-teaching outcome expectancy. The study was rooted in theoretical frameworks from Lave and Wenger's (1991) community of practice and Bandura's (1977) self-efficacy beliefs. The researcher used three surveys to examine schoolteachers' experiences of a community of practice and science-teaching efficacy beliefs. The instrument combined Mangieri's (2008) virtual teacher demographic survey, Riggs and Enochs (1990) Science-teaching efficacy Beliefs Instrument-A (STEBI-A), and Cadiz, Sawyer, and Griffith's (2009) Experienced Community of Practice (eCoP) instrument.

The results showed a significant linear statistical relationship between the science teachers' experiences of community of practice and personal science-teaching efficacy. In addition, the study found that there was also a significant linear statistical relationship between teachers' community of practice experiences and science-teaching outcome expectancy. The results from this study were in line with numerous studies that have found teachers who are involved in a community of practice report higher science-teaching efficacy beliefs (Akerson, Cullen, & Hanson, 2009; Fazio, 2009; Lakshmanan, Heath, Perlmutter, & Elder, 2011; Liu, Lee, & Lin, 2010; Sinclair, Naizer, & Ledbetter, 2010). The researcher concluded that school leaders, policymakers, and researchers should increase professional learning opportunities that are grounded in social constructivist theoretical frameworks in order to increase teachers' science efficacy.

Chapter One: Virtual School Teacher's Science Efficacy Beliefs

Effective execution of science education requires that teachers have a deep understanding of science content knowledge (National Research Council [NRC], 1996, 2000, 2007, 2011a, 2011b; Smith & Neale, 1989). However, studies have found that teachers are not fully prepared to implement the new content standards advocated in science education reform efforts (National Science Teachers Association, 2003). As a result, quality of instruction is poor because most teachers either avoid teaching science (Appleton, 2002, 2003; Hestenes, 2013; NRC, 2011b) or rely heavily on textbooks and worksheets (Appleton & Kindt, 2002; Davis, Petish & Smithey, 2006; NRC, 2011b). One promising approach to overcome teachers’ lack of content knowledge and therefore improve their teaching effectiveness is to involve them in a community of practice (Lave & Wenger, 1991). Studies have found that teachers who were participating in a community of practice reported better science content knowledge, higher teaching efficacy, and increased student achievement (Fulton & Britton, 2011; Lumpe, Czerniak, Haney, & Beltyukova, 2012; Sinclair, Naizer, & Ledbetter, 2010).

Problem Statement

Studies have found that teachers who participated in a community of practice in science-teaching reported having a better understanding of how to teach science-inquiry standards (Fazio, 2009; Goodnough, 2010). These studies indicate the need for school partnerships with science experts, collaborative learning, and learning continuity for teachers, but they do not examine how being a part of a community of practice affects self-efficacy of science teachers. Researchers have found that higher teaching efficacy leads to more effective science-teaching (Lumpe et al., 2012; Sinclair et al., 2010). However, there is limited research evaluating how being a part of a community of practice affects science-teaching self-efficacy, and the little research that exists focuses on teachers in a traditional "brick and mortar" environment, so that there has been no evidence for the effectiveness of the community of practice within virtual learning environments. With the rapid growth of virtual schools, it is important to examine science-teaching efficacy beliefs as they pertain to teachers in virtual classrooms. Because teachers in these environments are held to the same teaching standards as traditional teachers, it would be beneficial to examine their experiences in their communities of practice and the effects these experiences have on their science-teaching efficacy beliefs. This study explores the relationship of community of practice on science-teaching efficacy and science-teaching outcome expectancy of K–12 teachers in virtual teaching environments, who can also be described as virtual teachers.

Purpose Statement

The purpose of this study is to examine the factors within a community of practice that affect science-teaching efficacy beliefs of virtual K–12 teachers. Cadiz, Sawyer, and Griffith's (2009) Experienced Community Survey will be used to measure the extent to which a person experiences their community of practice. These factors are open communication, shared vocabulary, remembering previous lessons, and learning from each other (Cadiz et al., 2009). Riggs and Enochs' (1990) Science Teaching Beliefs Instrument-A (STEBI-A) will be used to measure science-teaching efficacy beliefs. This study seeks to provide understanding of factors that can enhance the efficacy and expectancy of teachers in online classrooms within their science-teaching community of practice.

Background

For over 50 years, the United States has greatly benefited from innovations in science and engineering. These innovations have created jobs, powered the U.S. economy, raised the quality of living, and enabled the U.S. to become an international economic leader (Atkinson, 2012). However, Atkinson reports that the country's global share in Science, Technology, Engineering, and Mathematics (STEM) industries is on the decline. Additionally, the global economy has increased its need for a STEM workforce (National Science Board [NSB], 2012). Although the U.S. has seen a steady growth in STEM professionals, it still lags behind Asian and European competitors (DeJarnette, 2012). In addition, the NSB (2010) reports that the number of students pursuing natural sciences and engineering degrees is decreasing. These fields are essential in today's knowledge-intensive global economy; therefore, if the United States is to remain competitive within the global economy, education reformers need to focus on preparing future generations of students to become literate in science.

Science Reforms

With ever-increasing changes in the global economy and the need for science and engineering professionals, initiatives have been passed to mandate more attention to science education in American schools (DeJarnette, 2012). These initiatives include national and state education policies that focus on improving student learning in science. These policy goals aim to increase student achievement and raise the international ranking of U.S. students in science from the middle to the top in the next decade (NSB, 2012). In 2011, only one-third of eighth-grade students in the United States scored proficient or above in science (National Assessment of Educational Progress [NAEP], 2012). Although the United States leads the world in spending per pupil, that spending is not translating into high achievement in science (Peng & Guthrie, 2010).

According to Peng and Guthrie (2010), the average U.S. expenditures per student increased by 25% from 1995–2006. However, the increase in spending did not equate to a dramatic increase in NAEP scores, which only increased by 3 percent (NAEP, 2012). These less-than-desirable scores have been linked to a lack of quality in science instruction (NRC, 2007). While the United States is spending more money than ever on education, student achievement scores have not measured up; as a result, more scrutiny is being placed on educational spending and education reform (Peng & Guthrie, 2010). Reforms include the creation of Common Core Standards that will be implemented across states and efforts to strengthen the quality of science curricula, encourage students to take advanced courses, increase teacher quality, raise graduation requirements, and expand technology use in education (NSB, 2012). These reforms aim to improve student achievement, but teachers play a central role in whether they succeed because it is teachers who must implement any new national, state, or district standards (Garet, Porter, Desimone, Birman, & Yoon, 2001).

Virtual Schools

Teachers who offer their instruction virtually are equally responsible as teachers in brick-and-mortar schools to help implement reforms that can improve student achievement in science. In the 2012–2013 school year, there were 31 U.S. states with K–12 virtual schools (Watson, Murin, Vashaw, Gemin, & Rapp, 2011). The increase in virtual schools has given students learning opportunities that were not previously available to them. For example, virtual K–12 schools have given rural school districts access to NCLB-qualified teachers in courses districts had previously been unable to provide (Watson & Ryan, 2007). Although the learning environment may be different from that in traditional schools, virtual schools are still responsible to deliver the same Common Core standards to their students (Watson & Ryan, 2007). This means that teachers in those schools are also held accountable to raise student science achievement just as teachers from traditional brick-and-mortar environments.

Professional Development

The federal policy commonly called No Child Left Behind (NCLB, 2001) was passed in an effort to improve the quality of education for students. Under NCLB (U.S. Department of Education, 2004), there has been an emphasis on school accountability, which heavily focuses on the role of teachers in student learning (Desimone, Porter, Garet, Yoon, & Birman, 2002; Lumpe et al., 2012; Sinclair et al., 2010). According to many researchers, the success of educational reform depends on teacher qualifications and effectiveness (Garet et al., 2001). As a result, teacher professional development has become a primary focus in educational reform efforts.

While most teachers support education reform, many are not fully prepared to implement teaching practices that require students to critically analyze and develop higher-order thinking skills (Borko, 2004; Cohen, 1990). Cohen suggests that teachers are trained to teach through the classic model of learning and memorizing, which does not require students to build a deeper understanding of the subject. If students are expected to become more analytical and better critical thinkers, teachers must be prepared to teach these high standards through professional development (National Board for Professional Teaching Standards, 1989, 2003).

Science Efficacy Beliefs

Studies show that traditional types of professional development for teachers are usually short-term and do not adequately prepare them for science inquiry learning and practice (Barber & Mourshed, 2007; Borko, 2004; Lumpe, 2007). However, professional development that was long-term and included hands-on experience, scientific experts, and master teachers was positively correlated with teacher content knowledge, teacher science efficacy, and the amount of time teachers taught science (Lumpe et al., 2012; NRC, 1996). Furthermore, some researchers found that professional development that focused on changing teacher efficacy beliefs and attitudes was correlated with improved student learning (Czerniak, Lumpe, & Haney, 1999; Knapp, 2003; Lumpe et al., 2012; Sinclair et al., 2010).

Numerous studies have indicated that teachers' feelings of self-efficacy can have a positive impact on their students' achievement (Akerson & McDuffie, 2006; Brown, Brown, Reardon, & Merrill, 2011; Duschl, 2008; Sinclair et al., 2010). Science teachers with higher feelings of science-teaching efficacy are more likely to teach science, to incorporate science-teaching reform standards, and to help their students build a deeper understanding of science (Appleton, 2003). Furthermore, studies have found a strong correlation between the hours, over 100 hours, teachers spend participating in intense professional development and their teaching self-efficacy (Desimone, 2011; Garet et al., 2001; Lumpe et al., 2012). Consequently, there is a critical need to examine how professional development affects teachers' beliefs, teaching practices, and student learning (Guskey & Passaro, 1994; Lumpe et al., 2012; NRC, 1996; Riggs & Enochs, 1990; Sinclair et al., 2010; Swafford, Jones, Thornton, Stump, & Miller, 1999).

Growing amounts of research stress the need to embed social constructivist-learning theories within professional development for teachers (Koch, 2005). Professional development techniques that are long-term, collaborative, and involve experts and peers are found to be highly effective for teacher learning and teacher self-efficacy (Fulton & Britton, 2011; Garet et al., 2001). These types of continual professional developments are best exemplified by Lave and Wenger's (1991) concept of community of practice.

Research Questions

This proposed research study seeks to examine the extent of how participation in a community of practice in science education will affect the science-teaching efficacy of K–12 teachers who teach in a virtual environment. Experience of community of practice (eCoP) will be measured using the Cadiz et al. (2009) instrument. The eCoP instrument was developed to measure the "extent to which a person is engaged in his/her community of practice" (Cadiz et al., 2009). Following the American Psychological Association and National Council on Measure in Education, Cadiz and colleagues developed field-appropriate measures of experience in a community of practice. It has origins in Lave and Wenger's (1991) concept of community of practice, which consists of people who share a common interest or profession with the goals of exchanging knowledge through open communication (Lave & Wenger, 1991).

Science-teaching efficacy will be measured by using Riggs and Enochs' (1990) Science-teaching efficacy Beliefs Instrument-A (STEBI-A) instrument. The STEBI-A is a survey designed by Riggs and Enochs (1990) to measure the level of science-teaching efficacy of in-service science teachers. The instrument measures science-teaching efficacy beliefs through two subscales: Personal Science-Teaching Efficacy (PSTE) and Science-Teaching Outcome Expectancy (STOE). It has its theoretical framework in Bandura's Self-Efficacy Social Cognitive (SESC) theory (Bandura, 1977) and Gibson and Dembo's (1984) teacher efficacy scale.

The following research questions will be explored in the study:

R1: What is the relationship between experience of community of practice and personal science-teaching efficacy (PSTE)? Which dimensions of experience in community of practice have the greatest effect on PSTE?

R2: What is the relationship between experience of community of practice and science-teaching outcome expectancy (STOE)? Which dimensions of experience in community of practice have the greatest effect on STOE?

Theoretical Framework

The theoretical framework supporting teachers' feelings of self-efficacy resulting in science-teaching efficacy improvement through community of practice is based in the theories of social learning.

According to Bandura's (1997) psychological social cognitive theory, self-efficacy is "the belief in one's capabilities to organize and execute the course of action required to manage prospective situations" (p. 2). Research supports the idea that self-efficacy plays a strong role in human behavior. Bandura (2000) writes:

> Perceived efficacy plays a key role in human functioning because it affects behavior not only directly, but by its impact on other determinants such as goals and aspirations, outcome expectations, affective proclivities, and perception of impediments and opportunities in the social environment. (p. 73)

Furthermore, research has shown that students' self-efficacy beliefs play a significant role in influencing their motivation and achievement (Bandura, 1997); in addition, researchers have discovered that teachers' self-efficacy beliefs also play an important role in influencing outcomes for teachers and students (Ross, 1992).

The notion of knowing and learning through situated activities forms the basis for a community of practice in which a learner participates (Lave & Wenger, 1991). A community of practice consists of individuals who interact with one another in order to achieve the same goal. For this research, the community of practice consists of science teachers. Researchers have found communities of practice that focus on teacher collaboration and continuity have a positive effect on teaching efficacy and student achievement (Akerson, Cullen, & Hanson, 2009; Fazio, 2009; Liu, Lee & Lin, 2010; Vescio, Ross, & Adams, 2008). Chase, Germundsen, Brownstein, and Distad (2001) found that teachers' efficacy increased when they are involved in an active community of practice, which consists of new teachers, experienced teachers, administrators, mentors, and faculty teacher educators who meet to reflect on their practices on a regular basis. Ramey-Gassert, Shroyer, and Staver (1998) found that teachers' personal science-teaching efficacy is influenced by their positive experiences with high-quality science courses, professional development, access to resources, and a supportive community of practice from peers and administrators. Consequently, developing science-teaching self-efficacy is an important goal for science education reform.

Implications for Research

Teachers who were involved in science community of practices report higher teaching efficacy (Knapp, 2003; Sinclair et al., 2010). In addition, research has found that higher teaching efficacy leads to more effective science-teaching and higher student achievement (Lumpe et al., 2012; Sinclair et al., 2010). The researcher is assuming that teachers in virtual settings share similar characteristics of a community of practice with teachers in traditional "brick and mortar" settings. Therefore, the study will provide insights about the community of practice and provide a springboard for further research on the community of practice for virtual schools. In addition, the study will seek to increase understanding of factors within a community of practice that affects science efficacy of virtual schoolteachers. The data will provide school districts, administrators, and stakeholders with instructional strategies to help them develop and maintain ongoing communities of practice to support K–12 teachers in virtual environments. Furthermore, results from this study will offer potential benefits including improvements in science-teaching efficacy, student achievement, professional development and community of practice for in-service teachers, and ideas about development of better science-inquiry curricula.

Summary of Methodology

This study is a descriptive, correlational, quantitative, nonexperimental survey study. The purpose of this study is to determine if relationships exist between personal science-teaching efficacy and science-teaching outcome expectancy and the independent variables of experienced community of practice: (a) open communication, (b) shared vocabulary, (c) remembering from previous lessons, and (d) learning from each other (Cadiz et al., 2009). These variables are treated as ordinal variables and measured quantitatively with a Likert scale. Two dependent variables were measured by the STEBI-A: science-teaching efficacy beliefs and science-teaching outcome expectancy.

Significance of Study

This study is significant because it will provide insight into ways teacher science efficacy beliefs can be improved in order to improve STEM education reform measures. Furthermore, understanding how a science teacher experiences a community of practice can provide professional development opportunities to enhance science-teaching efficacy beliefs. "Enhancing the quality and quantity of K–12 STEM education is inextricably linked to the continued professional development of K–12 teachers," according to Nadelson, Seifert, Moll, and Coats (2012, p. 69). While it is important to focus on students' science content knowledge, it is just as vital to focus on teachers' knowledge and pedagogy in science-teaching.

According to Nadelson et al. (2012), schools often lack teachers with the knowledge and expertise to teach science effectively. Furthermore, teachers lack the professional support, systems, and tools to fully implement science-focused lessons. Without the proper professional development and knowledge building, how will teachers inspire students to become competitive in the STEM global workforce? In addition, as virtual schools continue to proliferate in the United States, it is imperative that more research should be done on what policies and practices support teaching effectiveness for these schools. Therefore, focusing on improving teachers’ professional development opportunities may be beneficial in improving U. S. global competiveness and improving national prosperity (Nadelson et al., 2012). According to Nadelson, et al,

> The importance of STEM education to societal developments provides justification for assuring K–12 teachers are prepared to teach the related content. Inservice teacher professional development is critical to achieving the goal of enhanced student knowledge of STEM. (Nadelson et al., 2012, p. 69)

The success of science education reforms depends on teacher qualification, effectiveness, and teaching efficacy (Garet et al., 2001) for both traditional and virtual school teachers.

Limitations

The present study has several limitations. First, the participant population was gained through a sample of convenience. Because the sample consists of schoolteachers in virtual settings, the study’s findings cannot be generalized to the entire population of science teachers. Other science teachers in both virtual and traditional settings may have different responses. Second, the present research is only examining correlations between variables; therefore data will not identify causation. Third, self-reporting can be problematic as there may be social desirability bias. However, surveys are efficient and cost-effective in data collection for a large population (Babbie, 1998); furthermore, the instruments have demonstrated reliability and validity. Finally, the measures for experience of community of practice are relatively new; therefore, repeated studies utilizing the measures are recommended.

Definitions of Terms

The following terms and definitions are relevant to the topic being studied here.

Personal science-teaching efficacy beliefs: the confidence a science teacher has in his/her ability to successfully teach science.

Science-teaching outcome expectancy: the belief a science teacher has that effective science-teaching will influence his/her students.

Self-efficacy: the measure of one's own confidence in completing a task and reaching a specific goal.

Virtual schools: A form of distance education that delivers online courses or classes that cater to K–12 grade levels.

Virtual teachers: Teachers who teach at virtual schools.

Summary

In this chapter, I have shown the lack of research exploring the relationship between community of practice for science teachers in virtual schools and their science-teaching efficacy and science outcome expectations. I have presented background regarding the national need for science education reform and the relationship between professional development and the effectiveness of science teachers. Furthermore, I have provided the purpose of the study, which is to examine the extent of how virtual K–12 teachers' experience with a community of practice in science education can affect science-teaching efficacy. In addition, I have included the research questions:

R1: What is the relationship between experience of community of practice and personal science-teaching efficacy (PSTE)? Which dimensions of experience in community of practice have the greatest effect on PSTE?

R2: What is the relationship between experience of community of practice and science-teaching outcome expectancy (STOE)? Which dimensions of experience in community of practice have the greatest effect on STOE?

Finally, three limitations have been addressed: sample of convenience, the correlational data, and self-reporting of participants.

The following chapter will be a review of literature that addresses the science education reform movement in the United States and theoretical framework for this study: community of practice, self-efficacy, and science-teaching efficacy beliefs. Chapter 3 will examine this project's methodology. Chapter 4 will provide the results, and Chapter 5 will provide a summary of the project.

Chapter Two: Literature Review

This study will examine the relationship between community of practice and science-teaching efficacy beliefs of teachers in K–12 online schools. This chapter will address the science education reform movement in the United States, which includes science inquiry instruction and science literacy. The theoretical framework for this study will focus on teachers' community of practice, self-efficacy, and science-teaching efficacy beliefs. The review of literature will examine options for improved professional learning opportunities and development that could affect science-teaching efficacy beliefs. Lastly, this chapter will provide a brief background of virtual K–12 online schools and the need to examine the science-teaching efficacy beliefs of teachers in those schools.

Background

Many national, state, and local policymakers and educators have introduced education reform policies (Garet et al., 2001) in response to recent measurements showing low student achievement in the United States (NAEP, 2006). These education reforms include implementing higher educational standards, developing common core curriculum standards and frameworks, and using standardized testing to develop and measure advanced thinking and problem-solving skills among students (National Commission on Teaching and America's Future, 1996). While these reforms aim to improve student achievement, teachers play a central role in the success of executing education reform because they must carry out the demands of state and district standards (Cuban, 1990). Federal policy such as the legislation commonly called No Child Left Behind or NCLB (2001) was passed in an effort to improve the quality of education for students (U.S. Department of Education, 2004). Under NCLB, there has been an emphasis on school accountability, which emphasizes the role of teachers in student learning (Desimone et al., 2002;

Sinclair et al., 2010). The success of educational reform depends on teacher qualifications and effectiveness (Garet et al., 2001). As a result, teacher professional development has become a primary focus in the educational reform efforts.

While most teachers support education reform, many are not fully prepared to implement teaching practices that require students to critically analyze and develop higher-order thinking skills (Borko, 2004; Cohen, 1990; Hestenes, 2013). Cohen suggests this is because teachers have been trained to teach through the classic model of learning and memorizing, which does not require students to build a deeper understanding of the subject. If students are expected to become more analytical and critical thinkers, teachers must receive professional development to prepare them to help their students attain these higher standards (National Board for Professional Teaching Standards, 1989, 2003).

Science Education Reform

Due to our global economy's heavy reliance on technology, there is a higher demand for people who can solve complex problems and understand science and technology (Brown et al., 2011). In order to meet these demands, reform in science education is necessary (Brown et al., 2011). Research shows that students are not gaining science literacy at school (Cohen, 1990). In order for students to become more science literate, reforms must be made that will incorporate science inquiry teaching into the curriculum. Science inquiry teaching involves active learning strategies that engage students in the scientific process (NRC, 1996). Researchers have found that science inquiry teaching has been effective in building science literacy in students (Brown et al., 2011; Dani & Koenig, 2008; NRC, 1996).

The science reform movement for standards-based education began in the 1990s. Rutherford and Algren (1989) provided a foundation for high quality science education. The reform movement focuses not only on science but on education as a whole, advocating for high standards to develop students as critical thinkers who are capable of solving complex problems and applying abstract knowledge to real-world problems (NRC, 1996).

In order for students to gain scientific knowledge and critical-thinking abilities, teachers must actively implement science inquiry instruction. Science inquiry-based instruction shifts from the traditional use of textbooks and lectures to a more student-centered approach where students engage in “doing science” (Von Secker & Lissitz, 1999). The ultimate goal for science reform is to encourage students to become more proficient in utilizing scientific strategies to logically solve problems and to verbalize and discuss their findings. In order for this goal to be achieved, teachers need to feel confident that their teaching practices can enable the scientific method to naturally transpire in the classroom.

Science inquiry. The NRC (1996) states that scientific inquiry involves studying the natural world in a diverse way and proposing hypotheses based on the evidence derived from observations. The science inquiry process requires student to develop knowledge and understanding of the natural world, as well as an understanding of how scientists examine the natural world (NRC, 1996). When practicing the scientific inquiry process, teachers and students are expected to:

- Think critically, plan, and conduct scientific investigations in context.
- Gather and interpret data based on observations.
- Discuss their hypotheses, ideas, observations, and conclusions.
- Use diverse tools of science, mathematics, and technology to support their scientific investigations. (NRC, 1996)

Science inquiry-oriented instruction engages students in some manner such as asking questions, hypothesizing, generating, interpreting, and evaluating data (NRC, 1996). During science inquiry instruction, teachers help their students learn through the scientific method rather than transmitting information through lectures or from reading books (Marshall, Horton, Igo, & Switzer, 2009). In this way, students are "doing science" and developing science literacy, which is the foundation of K–12 science education reform (Duschl, Schweingruber, & Shouse, 2007). Evidence has indicated that science inquiry instruction has significantly increased student science literacy (Judson & Sawada, 2000), although teachers find the new processes challenging to implement.

Science literacy. Science education reforms use Rutherford and Algren's (1989) outline in *Science for All Americans* as a foundation to build scientific teaching strategies (Liang & Gabel, 2005). Scientific teaching breaks away from the traditional form of teacher-centered teaching to a more student-centered approach; it encourages students to use the scientific method as they actively engage building their science literacy (Dani & Koenig, 2008). Due to the national goal that all students must become science literate, The National Research Council established National Science Education Standards (NSES) in 1996. These standards were formed to guarantee that American students who have all the necessary resources and instructional tools achieve the national goal of scientific literacy.

According to NRC (1996) scientific literacy requires students to understand and process scientific concepts so that they can make personal decisions in civic and culture affairs and use their knowledge to aid the economy. Scientific literacy involves students having the ability to identify scientific issues as they pertain to local and national level political issues. Furthermore, students who are literate in science are able to ask questions and establish hypotheses based on their curiosity. The NRC (1996) stresses the need for teachers to utilize as many science-inquiry standards as possible in order to develop the understanding of science literacy in order to meet the demands of a complex global society.

Professional Development

The education reform movement acquired national attention, which led to the push to implement more standards-based instruction in public schools. The NCLB legislation set ambitious goals to raise student achievement (Borko, 2004). Borko adds that although there are numerous factors that contribute to education reform goals, the ultimate changes in the classroom rely heavily on teachers.

As a result, school districts and administrators are placing more focus on teacher professional development and teacher learning (Desimone et al., 2002; Lakshmanan, Heath, Perlmutter, & Elder, 2011; Lumpe et al., 2012; Smith & Desimone, 2003). Professional development is a crucial component in the reform effort (Garet, et al., 2001; Moore & Esselman, 1992). As mentioned in the previous chapter, STEM reform goals are to enable our students to become competitive in the future global economy. Unfortunately, studies have found that teachers are not adequately trained in teaching science-inquiry standards (Akerson & McDuffie, 2006; Brown et al., 2011; Duschl, 2008; Sinclair et al., 2010). Studies have found a strong correlation between the hours, over 100 hours, teachers spend participating in intense professional development and teaching self-efficacy (Desimone, 2011; Garet et al., 2001; Lumpe et al., 2012). Consequently, there is a critical need to examine how professional development methods affect teachers' beliefs, their teaching practices, and student learning (Guskey & Passaro, 1994; Lumpe et al., 2012; NRC, 1996; Riggs & Enochs, 1990; Sinclair et al., 2010; Swafford et al., 1999). The primary goal of this study is to examine the effects of participation in a community of practice (Lave & Wenger, 1991) on teachers' efficacy and teachers' science efficacy.

Science professional development. In recent years, the definition of science education has been modified (Hodson, 1998; NRC, 1996). Science education has shifted from focusing on student acquisition and memorization of technical concepts and science terminology to emphasize critical thinking skills, inquiry processes, reasoning processes, and application of scientific concepts and skills (Hand & Prain, 2006). While these science inquiry standards must apply to all K–12 students, most teachers in K–6 are not fully prepared to teach the science inquiry methods or curriculum (NRC, 1996). Most elementary teachers are usually "generalists" (Darling-Hammond, 1999); they do not have a teaching specialty, nor were they trained to teach science content or pedagogy. Akerson and McDuffie (2006) add that since the primary subject taught to younger students is literacy, K–6 teachers usually are not science specialists but literacy specialists. Elementary school teachers often avoid teaching science because they lack confidence in their ability to teach science well (Brown et al., 2011; Epstein & Miller, 2011; Moreno, 1999).

Although the National Commission on Science and Mathematics Teaching for the 21st Century (2000) provided recommendations to support elementary teachers through professional development in science-teaching, the recommendations do not fully prepare teachers for science instruction (Akerson & McDuffie, 2006). Moreno (1999) adds that while science professional development is offered to teachers, what is offered rarely fully prepares teachers to implement science inquiry-based curriculum. Teachers usually receive materials or textbooks for the use of science instruction but receive no guidance for effectively executing science lessons. Because they often lack science background knowledge and science-teaching preparation, many K–6 teachers are not prepared to teach science effectively. Sinclair et al. (2010) assert:

> This inadequate content knowledge causes lack of confidence in their ability to teach science. This lack of confidence, coupled with the need for students to perform well on high stakes testing in science, has led to an increase in requests for science professional development programs for elementary teachers. (p. 580)

Akerson and McDuffie (2006) add that professional development generally focuses on helping teachers to use certain materials. While the development can help teachers learn how to use the teaching materials effectively, not all materials, curricula, and strategies are equally effective for all students (Abell & Roth, 1992; Akerson & McDuffie, 2006; Sinclair et al., 2010).

Traditional professional developments are short-term workshops, which are often found to be inadequate in teacher learning and practice (Barber & Mourshed, 2007; Borko, 2004; Lumpe, 2007). Studies have found that long-term professional development that includes hands-on experience, scientific experts, master teachers, and experiential application has been positively correlated with teacher content knowledge, teacher science efficacy, and time spent teaching science (Lumpe et al., 2012; NRC, 1996). Furthermore, while studies found a connection between teacher professional development and student learning (Yoon, Duncan, Lee, Scarloss, & Shapely, 2007), some researchers have found that effective professional development includes an effort to change teacher beliefs and attitudes in order to improve student achievement (Czerniak et al., 1999; Knapp, 2003; Lumpe et al., 2012; Sinclair et al., 2010). Pajares (1992) found that there is a positive relationship between teachers' beliefs and their instructional practices. In addition, the focus on teachers' beliefs and attitudes is pertinent to the success of science education reforms (Lakshmanan et al., 2011; Lumpe et al., 2012; Sinclair et al., 2010).

While it is important to provide instruction for teaching content and inquiry processes to teachers (Akerson & McDuffie, 2006), it is just as vital to change teacher beliefs and attitudes in order to improve student achievement. Studies have found that there is a positive correlation between teaching self-efficacy beliefs, teacher effectiveness, and student achievement (Bruce, Esmonde, Ross, Dookie, & Beatty, 2010; Ramey-Gassert, Shroyer, & Stayer, 1998). More recent studies have consistently supported teacher efficacy and student growth (Goddard, Hoy, & Hoy, 2004; Lumpe et al., 2012). Furthermore, Berman, McLaughlin, Bass, Pauly, and Zellman (1977) found that reported higher teaching self-efficacy beliefs were positively related to student achievement and teachers' willingness to continue to effectively implement federally funded projects.

Self-Efficacy

Self-efficacy plays an essential role in the thought processes and emotions that empower goal-oriented actions (Tschannen-Moran & McMaster, 2009). Self-efficacy is the level of confidence a person has in achieving future goals (Bandura, 1977). The concept of self-efficacy evolved from Bandura's (1977) social cognitive theory. According to Bandura's (1997) social learning theory, self-efficacy is a psychological construct that refers to one's belief in one's own ability to successfully complete a specific task. Bandura (1977) further adds that self-efficacy is one's own perceived competence to form and complete the actions required to produce a given goal. Within Bandura's social cognitive theory, a triadic relationship between a person's behavior, environmental events, and personal factors work together to explain human functioning (Lumpe et al., 2012). Pajares (1992) suggests that a person can change their behavior by targeting one or all three of these factors. Consequently, self-efficacy can be manipulated and changed in suitable circumstances (Bandura, 1997).

In order to influence self-efficacy, it is important to understand that self-efficacy involves two subscales, personal expectancy beliefs and outcome expectancy beliefs, that serve as a predictor for behaviors. Personal expectancy beliefs measure one's belief in his or her capabilities to achieve an anticipated outcome, while outcome expectancy is one's beliefs that a certain behavior will result in a specified outcome (Bandura, 1997). Bandura (1997) states that an individual with high personal expectancy beliefs and outcome expectancy is likely to be more resilient during challenging efforts in order to reach the desired goal, while individuals who were low on both scales are more likely to give up if they do not easily reach their desired outcome. Therefore, behavior can be predicted utilizing the two subscales of self-efficacy, and the appropriate factors could be utilized to influence self-efficacy (Bandura, 1977).

Because self-efficacy affects human behavior, it is important to understand how self-efficacy beliefs are developed (Tschannen-Moran & McMaster, 2009). Bandura (1977) defined four strategies for developing self-efficacy: mastery experience, vicarious experience, social and verbal persuasion, and physical and emotional states. Because mastery experience is more direct, it is the most influential strategy for developing self-efficacy. For example, when a person masters a task, that individual gains self-efficacy; on the contrary, when a person fails a task, self-efficacy is lowered (Bandura, 1977). Vicarious experiences are less direct because they occur when a person observes someone modeling a certain task. If the model is successful, self-efficacy may increase; however, if the model is unsuccessful, self-efficacy may decrease (Tschannen-Moran, Hoy, & Hoy, 1998). Social and verbal persuasion occurs when an individual receives encouragement, affirmation, or praise. In effect, the social and verbal persuasion can encourage the person to continue to spend more energy and effort to achieve a goal. The final factor affecting self-efficacy is found in the physical or emotional states that occur synchronously when a person is performing a task. For example, if the individual is excited and positive about the task, self-efficacy increases. However, if an individual experiences anxiety and is uncomfortable, self-efficacy may be lowered (Goddard, Hoy, & Hoy, 2004).

If the two subscales of self-efficacy are determined, an individual's behavior can be predicted and appropriate strategies can be applied to improve self-efficacy, thus increasing the chance an individual will continue efforts to reach the desired outcome. In connecting the two subscales for influencing teachers' self-efficacy, Tschannen-Moran and McMaster (2009) found professional development that focuses on master experiences with follow-up coaching had a positive effect on teacher self-efficacy. When teachers reported higher self-efficacy, they were more likely to implement new teaching strategies (Tschannen-Moran & McMaster. 2009).

Ross and Bruce (2007) found that teachers who participated in vicarious experiences had an increase in teacher efficacy beliefs. Furthermore, Lakshmanan et al. (2011) report that teachers who attended monthly professional developments that incorporated best practices for executing standards-based instruction, trainings in reflective cognitive coaching, and discussions on implementation of standards of strategies reported having a significant increase in self-efficacy. Additional studies demonstrate the importance of teacher collaboration and community of practice on teacher self-efficacy (Bruce et al., 2010; Sinclair et al., 2010).

In connecting these four strategies to science teacher efficacy, professional development should be focused on both science curricula content and building science-teaching self-efficacy. As mentioned earlier, teachers generally are not confident in teaching science-inquiry curriculum and, as a result, are avoiding teaching science (Brown et al., 2011; Epstein & Miller, 2011). If the United States is to become competitive in the STEM global workforce, stakeholders and school leaders must shift traditional professional development from focusing primarily on curricula and handing out materials to enhancing teacher's science knowledge and self-efficacy.

Teacher Self-Efficacy

In recent years, education reform has called attention to teaching self-efficacy (Lumpe et al., 2012). Bandura (1997) indicated that teacher self-efficacy beliefs influence student achievement and motivation. Researchers found that teachers' self-efficacy beliefs positively affect teachers' attitudes and beliefs about teaching and instructional behaviors (Gibson & Dembo, 1984; Skaalvik & Skaalvik, 2007; Tschannen-Moran & Hoy, 2001). On the other hand, teachers with low self-efficacy beliefs struggle more in teaching, are more stressed, and have lower job satisfaction (Betoret, 2006).

With the recent call for educational reform, there has been increasing interest in current conditions in schools, specifically on the school climate, student achievement, school leadership, teacher learning, teacher beliefs and attitudes, teacher development, and teacher efficacy (Fulton & Britton, 2011; Lumpe et al., 2012; Soodak & Podell, 1997). Two Rand Corporation evaluation studies first conceptualized teacher efficacy based on Bandura's (1977) work. The Rand evaluation of 100 Title III Elementary and Secondary Education Act (ESEA) found that teacher efficacy was positively related to student achievement (Berman et al., 1977). Ashton and Webb (1986) found a significant relationship between teacher efficacy and student achievement on standardized testing in math and reading. Teacher efficacy is the belief of teachers in their ability to affect student outcome (Lakshmanan et al., 2011). Teacher efficacy has been identified as a factor that most consistently relates to teaching and learning and has been associated with student achievement, engagement, motivation, and students' self-efficacy beliefs (Anderson, Greene, &

Loewen, 1988; Ross, 1992; Soodak & Podell, 1997; Tschannen-Moran & McMaster, 2009). Furthermore, there is a growing body of empirical evidence that supports Bandura's (1977) theory that teachers' self-efficacy beliefs are related to teaching efforts, goal setting, persistence when lessons do not go as planned, and resiliency during challenging situations (Ashton & Webb, 1986; Guskey, 1986; Haney, Wang, Keil, & Zoffel, 2007; Tschannen-Moran & McMaster, 2009).

Researchers have found that there are positive effects of high teacher efficacy on instructional practices (Ross, 1998). Teachers with high self-efficacy were more likely to implement new strategies than were teachers with low self-efficacy (Ross & Bruce, 2007; Tschannen-Moran & McMaster, 2009), more willing to adopt new instructional tools in the classroom (Guskey, 1988; Ross, 1994), more willing to try new teaching ideas (Ross, 1998), and more willing to set higher goals and expectations in the classroom (Angle & Moseley, 2009).

Teachers with higher self-efficacy were more willing to change their behavior in order to adapt to new instructional programs intended to increase classroom effectiveness (Smylie, 1988). In addition, teachers with high teaching self-efficacy are more open to taking risks in the execution of difficult practices and are more comfortable with facilitating student learning (Ross, 1998). Gibson and Dembo (1984) found that teachers who had higher self-efficacy were more enthusiastic, reported lower stress levels, and were more satisfied with their teaching job. Finson, Riggs, and Jesunathadas (2000) found that teachers with higher self-efficacy spent more time teaching science, used more innovative and challenging teaching methods, and were more effective in teaching science.

Science-Teaching Self-Efficacy

The NRC (2007) reports that elementary education teacher certification and credentialing requires teacher candidates to complete only two college-level science courses, which many believe is not an adequate preparation for teaching science curriculum (Bradbury, 2010; Fulp, 2002). A recent report on teacher quality conducted over the last 20 years reveals a positive relationship between teachers who majored in science and student achievement (Kuenzi, 2008). However, only 2% of elementary teachers, 27% of middle school teachers, and 52% of high school teachers possess a degree in science or science education (Aud et al., 2012). Which means that many U. S. science teachers are not truly qualified to teach the subject (Kuenzi, 2008). In addition, there is a dramatic difference in teacher confidence to teach science compared to other school subjects. According to Fulp (2002):

> It is clear that elementary school teachers do not feel equally qualified to teach all academic subjects, with preparedness to teach science paling in comparison to mathematics, language arts, and social studies. Where fewer than 3 in 10 elementary teachers reported feeling well prepared to teach the sciences, 77 percent indicated that they were very well qualified to teach reading/language arts. (p. 14)

As mentioned in the previous section, teachers who do not feel qualified to teach science are less likely to spend much time teaching science in the classroom (Fulton & Britton, 2011). In order to build science-teaching qualifications and confidence, professional development methods have been created to boost teacher learning through innovative, inquiry-based instruction (Lakshmanan et al., 2011). Insufficient science content knowledge also may lower teacher self-efficacy (Swars & Dooley, 2010), thus highlighting the important of professional development techniques that focus on building content, pedagogical, and social cognitive components.

Riggs and Enochs (1990) contend that although science is required for all students in elementary schools, elementary teachers do not place high priority on teaching science; as a result, students are not receiving the high-quality science education they deserve. They suggested that many teachers are ineffectively teaching science because they have low levels of science-teaching efficacy. Therefore, it is imperative to determine science-teaching efficacy in order to contribute to reform movements in science achievement.

Yoon et al. (2006) found that science teachers’ self-efficacy had a strong influence on their ability to successfully implement new science curriculum and choose the best instructional practice for effective teaching. In addition, teachers with low self-efficacy stemming from lack of science subject-matter knowledge were more likely to teach as little science as possible and to rely heavily on textbooks, science kits, and experts (Harlen & Holroyd, 1997). Appleton (2003) found that as many elementary school teachers have difficulties teaching science they tend to avoid the subject. Some teachers use “token” science content in reading and social studies, and some teach based on their limited science knowledge. Furthermore, teachers with low self-efficacy in science were more likely to give up on students who have difficulties, criticize students who do not understand the material, ignore subject misconceptions, or move on without reteaching the lesson using a more comprehensible approach for their students (Bandura, 1993).

By contrast, teachers with high self-efficacy were more comfortable using instructional strategies that enhanced student learning (Woolfolk & Hoy, 1990) and to ask more open-ended questions that allowed their students to utilize higher-order problem-solving skills (Mulholland & Wallace, 2001). Teachers with high self-efficacy were more supportive in providing learning experiences for their students, open to reflect on their teaching practices, willing to reteach lessons that did not run smoothly, and more accessible to student inquiries (Schunk, 1991).

Studies have found that low teaching efficacy can affect how teachers view their capability to teach students (Bandura, 1993; Schunk, 1991; Woolfolk & Hoy, 1990). It is, therefore imperative that teachers continue training and learning through science professional development (NRC, 2007). In order to bridge the gap associated with underprepared teachers, professional development in science and STEM is critical for teachers to become more effective in meeting the needs of their students. Science professional development should focus on building teacher efficacy and practices, which will have a positive impact on student achievement (Gibson & Dembo, 1984; Goddard & Goddard, 2001; Moore & Esselman, 1992; Ross, 1992).

Ramey-Gassert et al. (1998) found that there is a positive correlation between a teacher's science self-efficacy and attitude toward science choosing to teach science and self-rated effectiveness in science-teaching. Teachers with higher science self-efficacy were more likely to teach the mandated hours of science to their students, while teachers with lower self-efficacy were more likely to avoid teaching science (NRC, 2007). If teachers are not teaching science, how will students learn and achieve? Professional development needs to be able to accommodate those teachers who lack science knowledge as well as teachers who are proficient in teaching science. Researchers suggest that professional development that focuses on social constructivist learning can enhance teachers' learning and build their self-efficacy (Guskey & Yoon, 2009; Liang & Gabel, 2005).

Social Constructivist Theory

There has been extensive research on the concept of learning–situated social interactions and practices (Bruner, 1990; Dewey, 1933; Lewin, 1946; Vygotsky, 1978). The traditional view of learning as an internal cognitive function has shifted to see knowing and learning as concepts of context, culture, situated activities, and practice (Bruner, 1990; Lave, 1988; Lave & Wenger, 1991). Thus, popular frameworks of situated learning have been integrated into learning interventions (Tinker & Krajcik, 2001) and provided a foundation to implement improvements in teaching. More importantly, situated learning has been recommended as an effective method for teacher learning (Guskey & Yoon, 2009; Yoon et al., 2007).

Traditionally, professional development methods have focused on a top-down approach to delivering teacher learning (Bruce et al., 2010; Guskey & Yoon, 2009). These professional development techniques lack learning continuity, are disconnected from teachers' daily practices, fail to promote collaboration, and do not take into account that teachers are adult learners (Darling-Hammond, 2005; Guskey & Yoon, 2009). This traditional method of executing professional development has been deemed ineffective (Bruce et al., 2010; Yoon et al., 2007). In a large-scale analysis conducted by Regional Education Laboratory-Southwest (RELS), 1,300 studies were examined on the effectiveness of teachers' professional development on student outcomes (Yoon et al., 2007). The RELS study found that only 9 of the 1,343 schools studied met the 2001 NCLB Act's criteria for rigorous standards and that these nine schools utilized experts who were able to align theory and practice, maintain teacher collaboration, support peer and expert coaching, and reinforce learning continuity. The RELS study therefore recommended that professional development should utilize strategies employed by these nine schools as a model for effective teacher learning (Yoon et al., 2007).

If teachers are expected to provide rigorous science inquiry standards to their students, professional development should be designed to support teachers as learners. In considering effective professional development, Bruce et al. (2010) stress that teachers should be a part of a sustained, collaborative, professional learning community. In analyzing two school districts in

Ontario, Bruce and colleagues found the school district that offered sustained professional learning communities reported higher teaching efficacy and higher student achievement compared to the second school district that utilized the traditional model for professional development. Professional development methods that considered teachers as adult learners were reported to be more effective and have a positive effect on student achievement (Bruce et al., 2010; Guskey & Yoon, 2009; Webster-Wright, 2009).

Current research stresses the need to embed social constructivist-learning theories within professional development methods (Koch, 2005). Professional development that encourages continual collaboration among experts and peers are found to be highly effective on teacher learning and teacher self-efficacy (Fulton & Britton, 2011; Garet et al., 2001). The social nature of learning is best exemplified by Lave and Wenger's (1991) situated learning theory, which posits that learning is the process of participation through social interactions. Wenger (1998) further broadens the concept of situated learning as being a part of a community of practice (CoP). Lave and Wenger (1991) suggest that a learner enters a community from the periphery and comes closer to the center through social interactions with existing members, which enables full, legitimate participation. Through legitimate participation, the learner gains knowledge and customs from the CoP and identifies herself as being a member of the community. A person can be a member of many CoPs, whether at work, in professional learning communities, schools, or other social groups (Lave & Wenger, 1991).

Community of Practice

There has been much interest in supporting and overlapping the concept of CoP since Lave and Wenger's (1991) publication, including the ideas of a professional learning community, a community of learners, a learning community, a community of inquiry, and community knowledge, just to list a few (Hung & Yuen, 2010). These conceptual models stem from or extend the concept of CoP, and they all share the supposition that social interaction and participation are fundamental to how people learn and become members of a community (Lave & Wenger, 1991). A CoP embodies language, artifacts, tools, beliefs, norms, and behaviors. A newcomer becomes a participant within a community of practice through mutual engagement and social interactions. These social interactions involve the exchange of knowledge between members through mutual engagement such as talking or teaching one another (Lave & Wenger, 1991). For the purpose of this study, the term *communities of practice* will be used interchangeably with *professional learning communities*.

There have been few studies that investigate teacher learning and teacher self-efficacy as they relate to being a part of a science-teaching CoP (Fazio, 2009; Lakshmanan et al., 2011; Liu et al., 2010; Sinclair et al., 2010). Lakshmanan et al. (2011) found that there was a positive correlation between teacher self-efficacy and instructional practices for teachers who participated in a professional learning community. Webster-Wright (2009) reviewed over 200 studies in professional development and professional learning and found that professional development needs to provide learning in context and offer continuity. They further add that professionals learn from practice and that knowledge is gained through this practice.

In their research, Lave and Wenger (1991) challenged the traditional view that learning is the transmission of abstract and decontextualized knowledge from one person to another. Instead, they introduced a theory for learning as being part of social interactions and critical concepts such as situated learning, CoP, and legitimate peripheral participation.

Situated learning. Studies have found that professional development sessions most often focus on distribution of science material and resources without providing social interaction connected to science inquiry practices and thus have been ineffective for teacher learning (Appleton & Kindt, 1999) and enhancing teaching self-efficacy (Akerson & McDuffie, 2006). Lave and Wenger (1991) argue that learning does not transpire in isolation and that a person learns from socially interacting with others—a CoP—who are attempting to obtain the same skills or knowledge. In addition to social interaction, Lave and Wenger contend that people learn best when they are given an appropriate context for learning. For example, a teacher wanting to learn how to implement a new science inquiry process may start by reading the teacher guide on science inquiry. This learning process is decontextualized and abstract. In order for her to become a more competent teacher in science, she attends professional development sessions in the science-teaching community. In this new CoP, the members share the same goal, which is to become a more competent science teacher.

Based on Lave and Wenger's (1991) concept of situated learning, a teacher learns how to utilize and implement new science-teaching practices through experienced teachers. In this social dynamic, she is the newcomer; the old-timer is the expert. As she continues to attend more professional developments, she becomes more active in the community. She is no longer an outsider, but a member in the science-teaching community. This process where the newcomer moves from the periphery to the community's center is known as legitimate peripheral participation. Through this progression, the newcomer becomes an old-timer.

Thus, learning occurs in social interactions within context, activity, and culture; this concept is known as "situated learning." Within situated learning, knowledge is socially distributed. Lave and Wenger (1991) assert that learning is useless unless it applied within the context that is intended for. The success of the science teacher depends on her social interactions between other teachers within the community. Therefore, learning must take place within a social setting. This setting is known as a CoP and offers teachers in situated learning activities a chance to collaborate with other members, which has been found to have a positive influence on teacher and student learning (Liu et al., 2010; Vescio et al., 2008).

Legitimate peripheral participation. According to Lave and Wenger (1991), the concept of legitimate peripheral participation provides a way to connect the relationships between newcomers and old-timers, the acquisition and dissemination of knowledge; and the transformation of identities. As a newcomer, learners participate in peripheral activities such as observing the experts, acquiring the culture's language, using the culture's tools, and organizing the cultures' beliefs and values.

In a CoP, access to an expert is vital to a member's learning experience (Lave & Wenger, 1991). Tschannen-Moran and McMaster (2009) found that professional development sessions that focus on mastery experience with follow-up meetings with expert coaches had a strong effect on teaching efficacy beliefs compared with teachers who did not participate in follow-up meeting with expert coaches. Teachers who interacted with the experts were more likely to report an increase in their teaching efficacy beliefs. In connecting Lave and Wenger's concept of CoP, when a teacher masters a new instructional practice with the assistance of an expert, the instructional practice becomes reified. Through situated activities and legitimate participation, the teacher will be able to internalize the science knowledge and transmit the knowledge to new teacher members. The success of membership in a CoP relies on the learner's motivation to engage in the community and the community's willingness to offer access to knowledge.

CoP can be connected to Vygotsky's (1978) social constructivism theoretical framework for learning, as his concept of Zone of Proximal Development (ZPD) provides a foundation for how people master skills through tool usage and social interactions. According to Vygotsky, ZPD is a shared space between a learner's actual development and what she can achieve (potential development) when provided with mediating tools (tools, signs, language, or more experienced human beings). Vygotsky (1978) explains that the ZPD is "the distance between the actual developmental level as determined by independent problem solving and the level of potential development" (p. 86). This learning is achieved with the help of adult guidance, a tool, or in collaboration with more knowledgeable members.

Mastery of knowledge is gained through the use of mediating tools and social interactions. Within this context, these social interactions are extended through professional development. Professional development techniques that focus on building a CoP meet two requirements for Vygotsky's (1978) learning theoretical framework: they provide a repository for knowledge and skills and can be used to extend social interactions. Professional development that connects science teachers with experts can serve as a way for new learners to gain accessibility to the learning community (Fosnot & Perry, 2005; Tschannen-Moran & McMaster, 2009).

According to Vygotsky (1978), the process of mediated memory and learning start externally (tools, signs, or language), and with practice learning becomes internalized as mastery occurs. People use external tools (tools, signs, or language) in order to mediate learning. Once the mediated tool is no longer necessary, the learning becomes memory, a process called internalization. Ultimately, through continual interactions within a science-teaching and learning community, teachers will build content knowledge, increase their science self-efficacy (Desimone, 2011; Garet et al., 2001; Sinclair et al., 2010), and internalize good teaching practices that transpire within a CoP. Figure 1 illustrates this relationship.

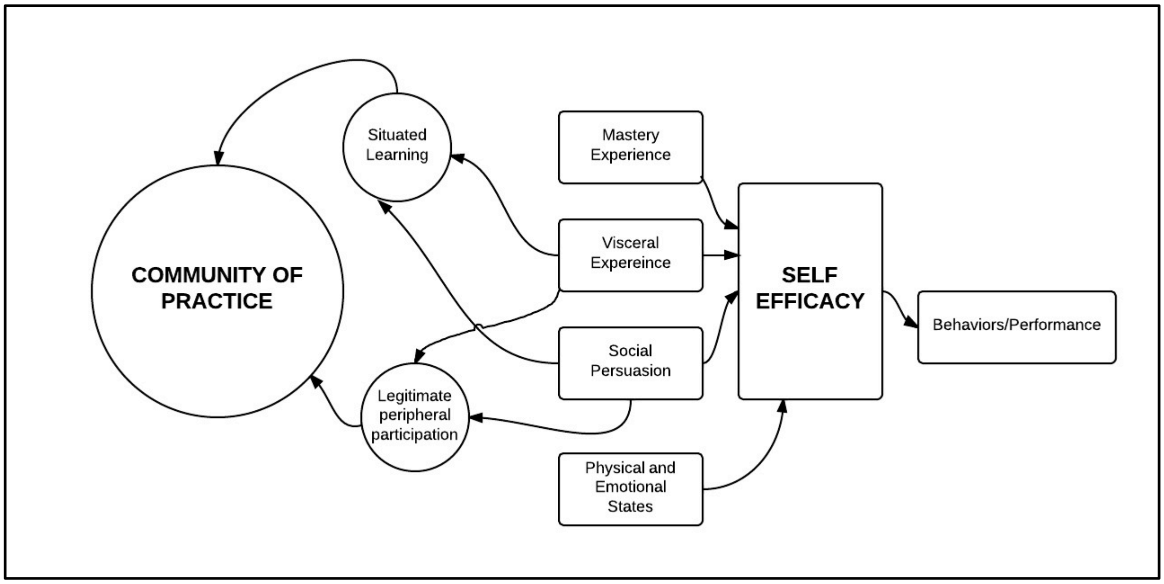

Figure 1. Relationship of self-efficacy and community of practice. Copyright 2014 by Phuong Uzoff.

To summarize the theoretical framework of Lave and Wenger's (1991) model for learning, there are three key interlinking concepts: situated learning, CoP, and legitimate peripheral participation. According to Lave and Wenger, learning does not occur in a vacuum but is situated in a CoP. Through the acquisition of knowledge, learners move from the community's periphery to the center in a process known as legitimate peripheral participation, which suggests that the growth of membership in a CoP is mediated by the accessibility that a newcomer has physically and socially.

Experienced Community of Practice (eCoP)

The success of a CoP relies on the experience of the members. Cadiz et al. (2009) propose that there are four dimensions in which a person experiences their CoP, and they created a survey to measure experienced community of practice (eCoP). The four dimensions of eCoP according to Cadiz et al. (2009) are:

- Open communication. Cadiz et al. (2009) suggest that without open communication, situated activities would not occur between CoP members, and as a result the community will dissolve. Open communication can be synchronous (face-to-face) or asynchronous (online, message boards, emails, and other virtual modes of interactions).
- Shared vocabulary. In a CoP, each member utilizes a common language or jargon to interact with other members in order to facilitate the transfer of information. With a shared vocabulary, the group establishes a sense of exclusivity, which Cadiz et al. (2009) say adds more value and motivation for an expert to attend and interact within a CoP. As long as the members grasp the shared vocabulary, the situated activities between members can continue. Wenger, McDermott, and Snyder (2002) assert that CoP becomes more effective if there is a shared vocabulary among members.
- Remembering previous lessons. Within a CoP, the main goal is to transfer best practices and lessons from member to member. For example, science teachers may discover that starting an inquiry lesson with a research question is vital for students to think critically and fulfills the science standards. The CoP becomes a great place to share the best science-teaching practices with other science teachers and archive them for CoP repository.
- Learning from each other. Through situated activities and legitimate participation, knowledge can be propagated between members within a CoP (Lave & Wenger, 1991). The purpose of a CoP is to exchange information between community members through group interactions. If the knowledge exchange is not valuable, the CoP becomes more of a social group or disappears (Lave & Wenger, 1991). A CoP

provides members a chance to learn from previous experiences and a place for new information to be applied to a common practice.

Cadiz et al. (2009) suggest that the more participants feel that their CoP has open communication, shares vocabulary, remembers previous lessons, and learns from each other, the better the eCoP for those participants. Figure 2 demonstrates the stages of development and the extent to which a member feels connected to their CoP. When participants are active, they are most engaged in their CoP. For the purpose of this study, it is important to measure the extent to which teachers feel connected to their science-teaching CoP.

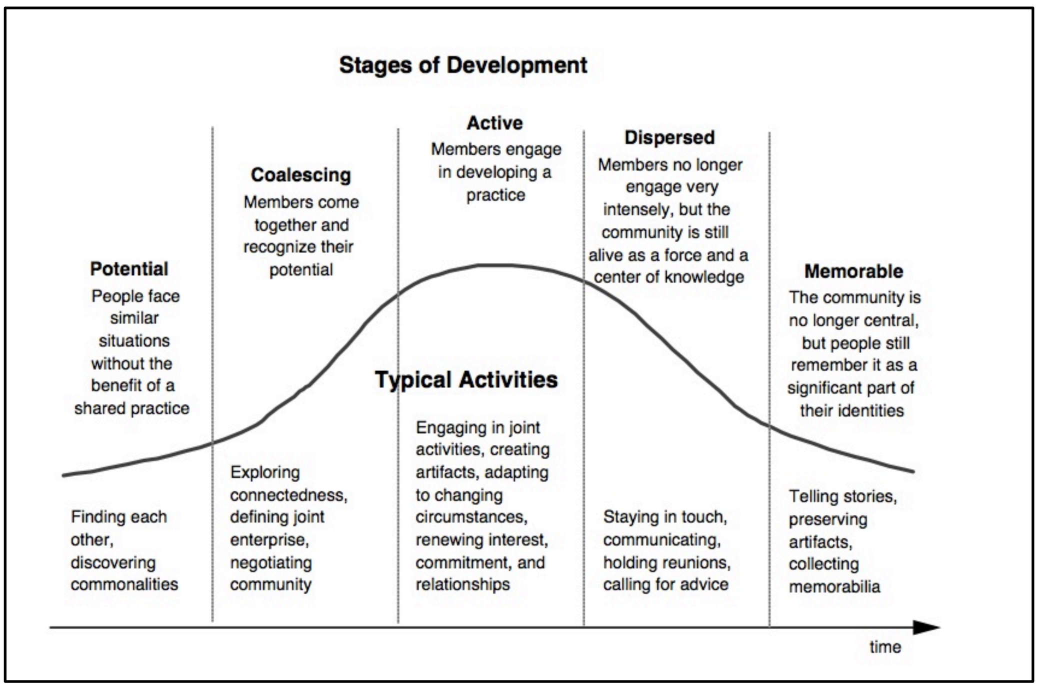

Figure 2. Stages of development for community of practice. From "Communities of Practice and Social Learning Systems" by E. Wenger, 2000, *Organization, 7*(2), pp. 225-246. Copyright 2000 by Sage Publishing. Reprinted with permission.

Education

The need for a CoP in science-teaching has been demonstrated by data collected from the Eisenhower Professional Development Program (Garet et al., 2001). The study was based on a national sample of 1,027 math and science teachers. Based on the sample, the researchers found empirical evidence that the best practices for professional development and teacher learning included:

- Learning opportunities that were sustained and intensive.
- Learning opportunities that focus on academic content.
- Learning opportunities that are more active and "hands-on."
- Learning opportunities that are integrated in the daily school practices.

Results from other studies also support these best practice outcomes for effective professional development (Cohen & Hill, 1998; Supovitz & Turner, 2000). CoP can potentially serve as a foundation for providing professional development that follows the best practices indicated by the research findings.

Communities of practice connect science teachers who have the same goal of learning, knowledge sharing, and collaboration in science-teaching and science education reform. Teachers who participated in a CoP in science-teaching reported they have a better understanding of teaching science standards and were more comfortable teaching science-inquiry lessons (Fazio, 2009; Goodnough, 2010). While this research indicates the need for school partnerships with science experts, teacher collaboration learning, and learning continuity, these studies do not examine how being a part of a CoP affects teaching self-efficacy. There is limited research evaluating how being a part of a CoP affects teaching self-efficacy, although research has found that higher teaching efficacy leads to more effective science-teaching (Lumpe et al., 2012; Sinclair et al., 2010). Therefore, it is vital to examine how being part of a CoP can provide a ZPD through situated learning and how legitimate participation can affect science-teaching efficacy beliefs.

Virtual Teacher Self-Efficacy Beliefs

In recent years, virtual schools have become more prevalent in the United States (Mangieri, 2008) and are now considered a legitimate method to deliver key instruction and a part of the everyday landscape for education (Strother, 2002). Virtual schools are a form of distance education that delivers online courses or classes that cater to K–12 grade levels. As more school districts provide students with virtual learning opportunities, there is a growing demand for highly qualified teachers for that environment. While there are similar components to teaching within traditional school settings and virtual environments, little is known about the experience of virtual teachers in their CoP and their effects on science-teaching efficacy beliefs. Currently, there is only one study that examines the effects of professional development, peer coaching, and support on teaching efficacy beliefs for virtual teachers.

Mangieri (2008) examined the efficacy beliefs of 39 virtual high school teachers at a Mississippi virtual school and evaluated how various professional development activities affected perceived teaching efficacy. The study found that continual professional development had a positive effect on teaching efficacy. Furthermore, two-thirds of the participants reported that peer coaching had a positive influence on their teaching efficacy beliefs and online teaching practice.

Mangieri's (2008) research on teaching efficacy demonstrates a need for more research on how virtual teachers can utilize their CoP to enhance their teaching efficacy beliefs. As mentioned in the previous section, teaching efficacy beliefs have been found to have a positive influence on teaching pedagogy and student achievement (Tschannen-Moran et al., 1998); therefore, understanding and enhancing teaching efficacy beliefs can potentially improve professional development, support, and training for virtual teachers.

Virtual Schools

This section provides a brief history on virtual schools and the need to study virtual teacher science efficacy beliefs. The National Center for Education Statistics (1999) defines distance education as classes offered in remote locations via audio, video, or computer technologies. These trainings and classes can be synchronous, asynchronous, or both. Web-based or Internet-based education is a form of distance education that utilizes the Internet for delivery of classes. Virtual schools are a form of distance education that delivers online courses or classes that cater to K–12 grade levels. Virtual schools can be run by public school districts, local education agencies, charter schools, colleges, regional agencies, and as nonprofit or for-profit (Simonson, Smaldino, Albright, & Zvacek, 2006). Virtual schools can operate as supplemental programs, full-time programs, blended online programs (courses that blend online and face-to-face instruction), or web-facilitated where between 1% and 20% of the content is delivered online (Watson & Ryan, 2007).

Since the launching of Utah's Electronic High School in 1994, virtual schools have grown in the United States at a significant pace (Hawkins, Graham, & Barbour, 2012). Setzer and Lewis reported in 2005 that 72% of schools districts were planning to expand distance education in the near future. According to a "Keeping Pace 2012 Report" for the school year of 2012–2013, two new fully online schools opened in Iowa and New Mexico, which brings the number of states with online schools to 31 (Watson, Murin, Vashaw, Gemin, & Rapp, 2011). A major factor in the rise of virtual schools is due to education reforms that call for educational choice and individualized instruction, which online distance learning can easily provide (Mangieri, 2008). In addition, Mangieri reports that educational entrepreneurs are capitalizing on the call for educational choice and providing online alternatives to traditional K–12 public schools. As more virtual schools are opening, there is also an increase in K–12 online student and teacher population (Archambault & Crippen, 2009).

With the rapid growth of K–12 online student and teacher population, the teacher's role in an online environment will also expand (Archambault & Crippen, 2009; Hawkins et al., 2012). Davis and Roblyer (2005) add that the characteristics and behaviors of effective face-to-face teachers are similar to virtual teachers; however, online teachers have new roles, responsibilities, and instructional pedagogy that must be initiated to become an effective online teacher. As a result, guidelines and standards for instructional practices for online environments have been adapted from face-to-face settings that emphasize content knowledge, communication skills, and instructional design (American Distance Education Council, 2003; Higher Education Program & Policy Council, 2000; South Regional Education Board [SREB], 2008). DiPietro, Ferdig, Black, and Preston (2008) add that while these guidelines provide a foundation for understanding online instructional practices and course design in online environments, they do not address the teaching skills needed for virtual school environments. With new guidelines and standards for teaching online, professional development sessions have been created to train virtual teachers (SREB, 2008). According to a report by SREB (2008), most virtual schools provide professional training and development for newly hired virtual teachers regardless of their years of experience in traditional schools. However, Watson and Ryan (2007) report that while state-led virtual schools continue to expand, few states have set policies and requirements for online teacher professional development.

In 2009, the SREB created the first Standards for Quality Online teaching, which define the qualifications of an online teacher and standards necessary for "academic preparation, content knowledge, online skills and delivery" (SREB, 2009). The guidelines provide state virtual schools with benchmarks for hiring, training, and evaluating online teachers (SREB, 2009). In their report, the board stressed the need for ongoing and continual professional development. Furthermore, SREB adds that teachers in traditional settings do not require technology as a primary means of communication in order to transfer content knowledge to their students, whereas with online teaching, technology skills are vital to transmit content knowledge to students. SREB recommends that ongoing professional development be offered to continue to strengthen virtual teachers' technology skills.

The SREB report (2009) recommends that professional development for virtual teachers should include both formal and informal training, with activities that range from online courses, workshops, Webinars, online communities, and forums. SREB highlights the need for CoP online as these communities will provide opportunities for virtual teachers to share ideas, discuss, illustrate, and collaborate with each other. These types of professional development activities should be designed to be flexible because most virtual teachers have different schedules than do traditional teachers. Unfortunately, the growth of K–12 virtual schools is such a recent phenomenon that few studies are available that investigate best practices for teaching in online environments and professional development of virtual teachers (Cavanaugh, Gillian, Kromrey, Hess, & Blomeyer, 2004).

Since the virtual teaching position is relatively new compared to the traditional brick-and-mortar school environment, there is a dire need to provide professional support and training for virtual teachers. Davis and Roblyer (2005) reported that virtual teachers felt disconnected from their faculty members and their students. Hawkins, Graham, and Barbour (2012) examined teachers at a virtual high school in Utah, where teachers reported feeling isolated from other virtual teachers. According to the study, virtual teachers reported that even though the high school teachers met monthly via synchronous professional development sessions, many teachers reported that they still felt isolated and alone because their colleagues were less accessible. According to Hawkins et al. (2012), "Teachers experience isolation as they struggled to learn from one another and to understand their performance compared in relation to others" (p. 137). Their study calls for a more collaborative online CoP where teachers can continue to share best practices and experience being part of a virtual online educator community.

In summary, with the expansion of virtual schools in the United States, there is a need to add to the growing body of literature on science-teaching efficacy beliefs as it pertains to virtual teachers. As more students are enrolling in virtual schools, more teachers are needed to deliver key educational standards (SREB, 2009). Since the growth of virtual schools is a recent phenomenon, more research needs to be conducted to gain a better understanding of how to train and retain teachers so they can provide high-quality instruction for students (SREB, 2009). As mentioned in the previous sections, teachers who participated in a professional CoP reported having higher teaching self-efficacy (Fazio 2009; Lakshmanan et al., 2011; Liu et al., 2010; Sinclair et al., 2010); therefore, it would be potentially beneficial to gain knowledge about the experience of virtual teachers in their CoP, and how their experience affects their science-teaching efficacy beliefs.

Summary

This review of literature supports the purpose of this study. The review highlighted the history of science education reform in the United States and revealed the need for teaching science inquiry instruction in order to build students' science literacy. In addition, the review of literature provided a basis for understanding how to improve professional development by emphasizing research that details successful and unsuccessful professional development methods and learning communities in order to build science-teaching efficacy. Detailed within this review was the theoretical framework for the study, which included social constructivism, community of practice, and self-efficacy. Furthermore, the review provided research relevant to teaching efficacy, particularly science-teaching efficacy, and the importance of a collaborative environment for teacher learning in the form of CoP. Finally, the last section provided the history of virtual online schools and the need for research on science-teaching efficacy of virtual teachers.

Further research employing quantitative methods is needed to add to the literature on science-teaching efficacy beliefs and the experience of CoP. While there has been some research that examined the relationship between the efficacy beliefs of teachers and their professional development, there has been little research that explores the relationship between science-teaching efficacy beliefs and CoP (Lumpe et al., 2012; Sinclair et al., 2010). Furthermore, only one study has found a positive relationship between virtual teachers' teaching efficacy and continual professional development (Mangieri, 2008). It is reasonable to assume that teachers who participate in a CoP and possess science-teaching efficacy are related. Therefore, it is useful to examine if there is a significant correlation between the experience of community of practice and science-teaching efficacy beliefs.

Chapter Three: Methodology

This chapter will present the methodology used for this study. The first section will provide an overview of the research design. The next section will outline the data collection procedures, including sample selection and instrumentation. Next, the methods of analysis are presented for evaluating each of the research questions. The last section will be a summary of the chapter.

Research has indicated that teachers who were involved in science communities of practice reported experiencing higher teaching efficacy (Knapp, 2003; Sinclair et al., 2010). In addition, researchers have found that higher teaching efficacy leads to more effective science-teaching and better student achievement (Lumpe et al., 2012; Sinclair et al., 2010). The purpose of this study is to examine the extent of whether K–12 teachers teaching in a virtual school experience a community of practice in science education and how that experience affects personal science-teaching efficacy and science-teaching outcome expectancy as measured by Riggs and Enochs' (1990) STEBI-A instrument. The study is rooted in theoretical frameworks from Lave and Wenger's (1991) community of practice and Bandura's (1977) self-efficacy beliefs.

Research Design

The researcher uses a descriptive, correlational, quantitative, nonexperimental survey design (Bryman, 2008; Creswell, 2009) for this study. "Quantitative research questions inquire about the relationships among variables that the investigator seeks to know. They are used frequently in social science research and especially in survey studies," according to Creswell (2009, p. 132). Furthermore, the purpose of survey designs is to make descriptive assertions about a certain population (Babbie, 1998). In addition, correlational research used to assess two variables of interest that may be related ultimately enables a researcher to draw conclusions that "allow the researcher to speak to some issue in the real world" (Hancock & Mueller, 2010, p. 55). For the present study, the relationship between teachers' reported experiences in a community of practice and their science-teaching efficacy beliefs are examined through validated and reliable survey instruments.

While it is important to utilize theoretical concepts in research, Kumar (1999) states that concepts should be operationalized in measurable terms in order to reduce and eliminate variability in respondents' understanding of the concepts. These measurable terms are called variables (Kumar, 1999). For the present study, the variables will be ordinal and will be measured quantitatively with a Likert scale. "The goal of Likert-scale is to measure intensity of feelings about the area in question" (Bryman, 2008, p. 146). For the purpose of this study, the areas are teachers' reported experiences in a community of practice and their science-teaching efficacy beliefs. The independent variable is experienced community of practice measured by the Experienced Community of Practice Scale (eCoP) (Cadiz et al., 2009). The independent variables as measured by the eCoP scale are open communication, shared vocabulary, remembering previous lessons, and learning from each other. The dependent variables are science-teaching efficacy beliefs and science-teaching outcome expectancy measured by STEBI-A (Riggs & Enochs, 1990). Following are operationalized definitions:

- Experienced community of practice (eCoP): the measure of participants' "subjective experience of membership in a community of practice" (Cadiz et al., 2009);
- Personal science-teaching efficacy beliefs: a science teacher's confidence in her or his ability to successfully teach science;

- Science-teaching outcome expectancy: a science teacher’s expectations that effective science-teaching will influence his or her students.

Measures

As described in Chapter 1, this research study seeks to examine the extent of how virtual K–12 teachers’ experience in a community of practice in science education can affect their science-teaching efficacy. Experience of community of practice will be measured using Cadiz et al. (2009) eCoP instrument. The instrument has origins in Lave and Wenger’s (1991) concept of community of practice, which consists of people who share a common interest or profession coming together with the goal of exchanging knowledge through open communication (Lave & Wenger, 1991).

Science-teaching efficacy will be measured by using Riggs and Enochs’ (1990) STEBI-A instrument. The Science-Teaching Efficacy Beliefs Instrument-A (STEBI-A) is a survey designed by Riggs and Enochs (1990) to measure the level of science-teaching efficacy of in-service science teachers. The instrument measures science-teaching efficacy beliefs through two subscales: Personal Science-Teaching Efficacy (PSTE) and science-teaching outcome expectancy (STOE). It has its theoretical framework in Bandura’s self-efficacy social cognitive theory (Bandura, 1977) and Gibson and Dembo’s (1984) Teacher Efficacy Scale.

Research Questions

The purpose of this descriptive, correlational, quantitative, nonexperimental study is to determine if relationships exist between personal science-teaching efficacy, science-teaching outcome expectancy, and the identifying variables of experienced community of practice: (a) open communication, (b) shared vocabulary, (c) remembering from previous lessons, and (d) learning from each other. The following are research questions that will be explored in the study.

R1: What is the relationship between experience of community of practice and personal science-teaching efficacy (PSTE)? Which dimensions of experience in community of practice have the greatest effect on PSTE?

R2: What is the relationship between experience of community of practice and science-teaching outcome expectancy (STOE)? Which dimensions of experience in community of practice have the greatest effect on STOE?

Instrumentation

Three surveys were used for this research. The three surveys were combined into one on a web-hosting site on SurveyMonkey.com. SurveyMonkey is an online survey tool that researchers use to create surveys, then post them on the encrypted website or email them to participants (Creswell, 2009). In addition, SurveyMonkey can generate results and reports in the form of descriptive statistics and graphs. These results can be downloaded into a spreadsheet for further data analysis. The following section will describe the instrumentation that will be used in this research.

Demographic data sheet. The researcher uses Mangieri's (2008) demographic survey that examined the teaching efficacy of virtual teachers. Her demographic survey will provide basic foundational information about virtual teachers. Permission to use and modify Mangieri's demographic survey was gained through email communication (Appendix A); the demographic survey was modified to fit the purpose of this research. The modifications included omitting the first three questions from Mangieri's demographic survey. For the purpose of this research, virtual teachers and virtual teaching settings are the primary concern. Mangieri's first three questions pertain to teaching in face-to-face teaching environments. The data that will be collected in the present study will include community setting for online teaching position, years of face-to-face teaching experience, years of online teaching experience, primary content area for online teaching position, types of professional development for online teaching, and gender. A copy of the demographic data survey can be found in Appendix B. This demographic survey will be added to SurveyMonkey.

Experienced Community of Practice (eCoP). Cadiz et al. (2009) developed two surveys that measured absorptive capacity (an individual's ability to transform new knowledge into useable knowledge) and experienced community of practice (the degree to which a person is involved in a community of practice). While Cadiz and colleagues developed both an absorptive capacity (aCaP) scale and experienced community of practice (eCoP) scale in their research, only the eCoP scale will be measured in this study. As stated in Chapter 1, the purpose of this study is to determine if there is a relationship between the experiences of virtual teachers in their communities of practice and science-teaching efficacy beliefs; therefore, it is not necessary to use the aCaP scale. While individual knowledge is vital to developing science efficacy, numerous studies have found that teachers who are isolated from their professional community of practice are less likely to report high teaching efficacy and are less likely to teach science (Czerniak et al., 1999; Knapp, 2003; Sinclair et al., 2010). Therefore, eCoP was chosen to be the best instrument to measure an individual's engagement in a community of practice.

The experienced community of practice scale (eCop) was developed to measure the "extent to which a person is engaged in his/her community of practice" (Cadiz et al., 2009). Cadiz et al. (2009) developed field-appropriate measures of experience in a community of practice. It has origins in Lave and Wenger's (1991) concept of community of practice (CoP), which consists of people who share a common interest or profession with the goals of exchanging knowledge through open communication (Lave & Wenger, 1991).

The eCoP survey consists of a 7-point Likert-type scale for each of the items, anchored from 1 = *strongly disagree* to 7 = *strongly agree.* Each researcher independently created a pool of three to five items aligned with the strong theoretical framework. The four dimensions of eCoP are open communication, shared vocabulary, remembering previous lessons, and learning from each other. Cadiz et al. (2009) assert that people will experience the greatest sense of their community of practice if open communication provides opportunities to use the shared vocabulary and people are able to learn from each other and their previous lessons. The eCoP scale can be found in Appendix C.

Science-Teaching Efficacy Belief Instrument-A (STEBI-A). The STEBI-A is a survey designed by Riggs and Enochs (1990) to measure the level of science-teaching efficacy of in-service science teachers. The instrument measures science-teaching efficacy beliefs through two subscales: personal science-teaching efficacy (PSTE) and science-teaching outcome expectancy (STOE). It has its theoretical framework from Bandura's self-efficacy social cognitive theory (Bandura, 1977) and Gibson and Dembo's (1984) Teacher Efficacy Scale.

The survey is composed of 25 Likert-scale items, each of which has five response ratings, ranging from 5 to 1 accordingly: *strongly agree, agree, uncertain, disagree,* and *strongly disagree.* Thirteen of the items: 2, 3, 5, 6, 8, 12, 17, 18, 19, 21, 22, 23, and 24 measure PSTE, while the remaining 12 items: 1, 4, 7, 9, 10, 11, 13, 14, 15, 16, 20, and 25 measure STOE. The following questions were reverse scored to ensure consistent values between positively and negatively worded questions: 3, 6, 8, 10, 13, 17, 19, 20, 21, 22, 24, and 25. The STEBI-A can be found in Appendix D.

Reliability and Validity

To ensure the quality of the instruments, reliability and validity were considered. Bryman (2008) writes:

> Both reliability and measurement validity are essentially concerned with the adequacy of measures, which are most obviously a concern in quantitative research. Internal validity is concerned with the soundness of findings that specify a causal connection, an issue that is most commonly concern to quantitative researchers. (p. 33)

The following provides reliability and validity results from the eCoP Scale and STEBI-A Instrument.

eCoP scale reliability and validity. Internal consistency and construct reliability were evaluated by interpreting the squared standardized factoring loading for eCoP constructs. Using a two-way random effect in SPSS and construct reliability resulted in a coefficient score of .769 for communication, .806 for vocabulary, .804 for remembering past lessons, and .852 for learning from each other. Each estimated construct reliability was measured against a .80 guideline. Although communication construct was below .80 construct reliability, the researchers argue that the shared variance between the constructs and their measures outweigh the shared variances between error variance (Cadiz et al., 2009).

Validity ensures the "integrity of the conclusions generated from a piece of research" (Bryman, 2008, p. 33). Results from path analysis to test criterion-related validity demonstrated that the measures are internally consistent, are related to the variables, and provide explanatory power (Cadiz et al., 2009).

STEBI-A reliability and validity. Criterion and content validity of the STEBI-A were pilot tested, and expert judges "contributed to the instrument's content validity" (Riggs &

Enochs, 1990). The panel clarified dimensions for each item and anchored scale. Reliability was tested through a pilot and major study. Riggs and Enochs tested internal reliability by conducting Cronbach's alpha in their pilot study. Cronbach's alpha is typically used to test internal reliability, and the figure .80 is used to indicate an "acceptable level of internal reliability" (Bryman, 2008, p. 151). The PSTE subscale Cronbach's alpha was .92, and the STOE subscale was .74 (Riggs & Enochs, 1990).

The major study included a sample of 331 in-service elementary teachers. The final data analysis resulted in Cronbach's alpha of .92 PSTE subscale, and Cronbach's alpha of .77 for STOE subscale. Riggs and Enochs (1990) suggest that possible explanations for the lower STOE subscale alpha score was that science-teaching outcome expectancy has been historically a difficult construct to define and measure, and teachers may lack science content knowledge. "Construct validity is based on the way a measure relates to other variables within a system of theoretical relationships" (Babbie, 1998, p. 134). To establish construct validity, Riggs and Enochs ran a Pearson *r* correlation test. They found that all criteria were significantly correlated in a positive direction. The researchers concluded that the STEBI is a "valid and reliable tool" (Riggs & Enochs, 1990, p. 633) to examine science-teaching efficacy beliefs and teacher learning.

Participants

Participants will be drawn from a sample of convenience within an education management organization, which serves 85 counties within the 50 states. The population in this study will be teachers who taught science during the 2013–2014 academic school year for virtual schools managed by the education management organization. The participants are part of a subset of online teachers who teach science online in K–12 virtual schools. The secured list from the education management organization will be accessible after Pepperdine Institutional Review Board (IRB). Approval for research has been given by the education management organization (Appendix E).

Procedure

Initial correspondence between the education management organization and the researcher regarding this project took place on February 21, 2014, when a proposal was sent to the director of academic services. The director granted approval for the research on March 10, 2014. Upon IRB approval, data collection occurred. An IRB exempt application was submitted to Pepperdine Institutional Review Board, where it was determined to meet exempt status as outlined in 45 CFR-46.1010 (b) (2) and CFR 46.117(c) since the research involves a survey with an adult population that is not protected (see Appendix F).

The teacher consent email (Appendix G) was sent to the director of academic services who sent the email to potential participants. The copy of the email includes the description of the study, indicates this study is strictly voluntary, and informs participants they can discontinue their participation at any point in the study. In addition, the email provides a list of participants' rights and explains potential risks and benefits of the study. The only identifiable risk was the time participants must spend to complete the survey. Participants were informed that the survey would take approximately 30 minutes to complete. Furthermore, the survey indicated that participants should complete it after working hours as to not interfere with district time. Potential participants were also informed that the survey is completely anonymous. To protect the identity of participants, no information that could be linked to the participants' identity was collected. The web link to the survey was embedded in the email; by clicking on the link, the participants tacitly gave approval to consent to participate in the present research.

The Demographic Survey, eCoP Scale, and STEBI-A instrument were combined as one survey on SurveyMonkey. The survey was self-administered through SurveyMonkey, which is a secure web-hosting survey site. Users accessed the secured link, and Secure Socket Layers (SSL) technology protected users' responses, which were encrypted to ensure that all user data will be safe, secure, and available only to the researcher. Participants accessed the embedded web link to SurveyMonkey and indicated their answers by clicking on the appropriate radio buttons. A reminder email to complete the survey was sent to participants two weeks after the initial email. A subsequent reminder email was sent to participants one month after the initial email. The survey remained open for two months. The data was securely stored on SurveyMonkey, and the only person who has the password is the researcher. The researcher will also keep the data in a password-protected file on an external hard drive for in a locked file cabinet to which only the researcher has access. The data will be destroyed after five years.

Data Analysis

The SPSS statistical program was used for analyzing data. After the survey web link closed, the researcher entered the data and ran descriptive statistics for each variable, and determined the mean, standard deviation, and mode. Each statistical test will be one-tailed. In order to avoid a Type I error, the researcher will set an alpha at .05. Listed below are the hypotheses and the statistical test conducted.

Hypotheses 1 and 2

R1: What is the relationship between experience of community of practice and personal science-teaching efficacy (PSTE)? Which dimensions of experience in community of practice have the greatest effect on PSTE?

H1: There is a significant relationship between experience of community of practice and PSTE. The dimension of "learning from each other" measured by eCoP instrument will have the greatest effect on PSTE.

R2: What is the relationship between experience of community of practice and science-teaching outcome expectancy (STOE)? Which dimensions of experience in community of practice have the greatest effect on STOE?

H2: There is a significant relationship between experience of community of practice and STOE. The dimension of "learning from each other" measured by experienced community of practice (eCoP) instrument will have the greatest effect on STOE.

"Pearson *r* is a method for examining relationships between interval/ratio variables" (Bryman, 2008, p. 327). Since Hypotheses 1 and 2 examine the relationship between the independent variable and dependent variable, a Pearson's *r* analysis was run to determine if a relationship exists between the variables for the first part of the hypotheses.

Because Hypotheses 1 and 2 have one dependent variable and multiple independent variables that may affect the dependent variables, a regression model was performed for the second part of the hypotheses. Babbie (1998) writes, "Survey researchers very often find that a given dependent variable is affected simultaneously by several independent variables. Multiple regression analysis provides a means for analysis such situations" (p. 308). In addition, a bivariate analysis was used to identify relationships between gender, geographic area, and teaching experience and PSTE and STOE.

The researcher hypothesizes that the dimension of "learning from each other" will have the greatest effect on PSTE and STOE. According to researchers (Akerson et al., 2009; Lave & Wenger, 1991; Wenger et al., 2002), learning from one another is a key factor in the success of a community of practice. It is therefore worth examining if the dimension of "learning from each other" within the eCoP scale has the greatest effect on science-teaching efficacy beliefs.

For each hypothesis, the researcher performed tests to ensure that there were no violations of normality, linearity, and homoscedasticity.

Ethical Issues

In designing a research study that involves human participants, researchers must take ethical issues into account. The present research has been designed to ensure the rights, safety, and welfare of potential participants. The Institutional Review Board at Pepperdine University reviewed the research proposal to ensure that all necessary precautions were taken (Appendix F). Once Pepperdine approves it, the study will be reviewed the education management organization. Once approved by both boards, informed consent will be sent to participants. Participants were told that their participation was completely voluntary; in addition, participants were allowed to discontinue their participation at any point in the study. Anonymity of potential participants was addressed; as noted earlier, no identifying data will be linked to the identity of participants, and the survey was anonymous. Lastly, the only harm that is present in this study is participation time. Participants will be informed that the survey should be taken during nonworking hours.

Limitations

As with most research, there are some limitations to the present study. First, the participant population was gained through a sample of convenience. Therefore, the results cannot be generalized to the entire population of science teachers. Although, Bryman says a "convenience sample probably plays a more prominent role than is sometimes supposed" (2008, p. 183), Bryman also cautions that the data will not provide definitive findings. However, the data can provide a "springboard for further research or allow links to be forged with existing findings in an area" (Bryman, p. 183). Second, the present research only examined correlations between variables; therefore, data does not identify causation. Third, self-reporting can be problematic as responses may reflect social desirability bias, which is "the distortion of data that is caused by a respondent's attempts to construct an account that conforms to a socially acceptable belief or behavior" (Bryman, 2008, p. 699). However, surveys are efficient and cost-effective in data collection for a large population (Babbie, 1998); furthermore, the instruments have demonstrated reliability and validity.

Summary

This chapter details the methodology employed to conduct the present study. The researcher has provided a detailed description of this study, including: (a) the theoretical basis for conducting research, (b) the research design, (c) the instrumentation, (d) the reliability and validity of the instrumentation, (e) the research questions and hypotheses, (f) the participants, (g) the procedure, (h) the data analysis, (i) the ethical issues, and (j) the limitations of the study. It is the researcher's hope that the data collected will provide a better understanding of how science-teaching efficacy beliefs can be affected within a community of practice in a virtual teaching community. The data may provide information that can help facilitate the development of professional communities of practice to assist virtual teachers in order to improve their science-teaching efficacy beliefs.

Chapter Four: Results

Results of the study are presented in this chapter. The first section provides participants' demographics, and the next section records the findings related to the research questions, hypotheses, and analyses. The last section will be a summary of the chapter.

The purpose of this study is to examine to what extent teachers for a K–12 virtual school experience a community of practice in science education and how that experience affects personal science-teaching efficacy and science-teaching outcome expectancy as measured by Riggs and Enochs' (1990) STEBI-A instrument. The study is rooted in theoretical frameworks from Lave and Wenger's (1991) community of practice and Bandura's (1977) self-efficacy beliefs. Three reliable and validated instruments were used to collect data: Mangieri's (2008) Demographic Survey; Cadiz et al.'s (2009) Experience Community of Practice Instrument; and Riggs and Enochs' (1990) Science-teaching efficacy Beliefs Instrument-A (STEBI-A). The researcher used a descriptive, correlational, quantitative, nonexperimental survey design (Bryman, 2008; Creswell, 2009) for this study. SPSS was used to analyze data.

Demographics

Participants were drawn from a convenience sample of teachers for online classes within an education management organization that serves 85 U.S. counties. The participants are part of a subset of teachers who taught science online in K–12 virtual schools during the 2013–2014 academic school year. An email with a web link to the survey was sent potential participants; the email was also embedded in the education management's newsletter and community page. A reminder email was sent two weeks after the initial message. A subsequent reminder email was sent to participants one month after the initial email. The survey was hosted on SurveyMonkey and remained opened for two months. Of the 118 invited to participate via email, 58 completed the first eight questions, but only 44 participants completed the entire instrument. Incomplete survey responses were omitted from the data analysis to avoid skewing the results.

A modified version of Mangieri's (2008) demographic survey was used to collect information on participants' teaching community setting, face-to-face teaching experience, online teaching experience, and professional development activities. The results for participants' demographics are shown in Table 1. The majority of participants teach in suburban community settings (74%). Twenty-four participants (43%) have five to ten years of teaching in face-to-face settings; nineteen participants have more than 10 years of face-to-face teaching experience (34%); and two participants have less than one year of face-to-face teaching experience. The majority of participants have one to four years of experience teaching online (54%). Thirty-five participants (64%) indicated that they taught science as their primary content area, while five (9%) taught English, and seven taught math as their primary content area. The majority of participants (65%) taught high school. Participants were also asked to provide their gender, although this was an optional question. Most respondents (80%) were female.

Table 1

Demographics of Participants

Respondent characteristics	*N*	% / Mean
Sociodemograhics / teaching experience		
Gender	*54*	
Female	43	80
Community setting	*57*	
Suburban	42	74
Urban	19	33
Rural	25	44
Face-to-face teaching experience	*56*	
< 1 year	2	4
1 to 4 years	11	20
5 to 10 years	24	43
> 10 years	19	33
Online teaching experience	*56*	
< 1 year	9	16
1 to 4 years	30	54
5 to 10 years	15	27
> 10 years	2	4
Primary content area		
English	5	9
Math	7	13
Science	35	64
Grade/level in which teaching science	*52*	
None	5	10
Elementary school	5	10
Elementary and middle school	3	6
Middle school	5	10
High school	34	65

Note. Mean percentage rounded to nearest percentile

The demographic survey also asked questions about the different types of teacher professional development activities. Results are shown in Table 2. The professional development consisted of initial training in online pedagogy, initial training in technology training, supported mentorship, mandatory professional development workshops, optional professional development workshops, and informal professional development activities (Mangieri, 2008). Forty-seven respondents (85%) indicated that they received initial online technology training professional development, which prepared them technologically to teach online. However, only 39 teachers (71%) reported attending initial pedagogy training to prepare them to teach an online course. Ongoing professional development results are as follows: 46 (84%) reported attending mandatory professional development; 39 teachers (71%) participated in optional professional development; 31 teachers (56%) reported participating in supported mentorship; and 31 teachers participated in informal professional development. Although the research questions did not specifically examine professional development activities, it would be beneficial in future studies to understand the different types of community of practice activities and training.

Table 2

Professional Development (PD) Activities

Types of activities reported by respondents	*N*	% / Mean
Supported mentorship	31	56
Informal professional development (PD)	31	56
Initial training: online pedagogy	39	71
Optional formal PD workshops	39	71
Mandatory, formal, online PD workshops	46	84
Initial technology training	47	85

Note. Mean percentage rounded to nearest percentile.

Results

The purpose of this descriptive, correlational, quantitative, nonexperimental study is to determine if relationships exist between personal science-teaching efficacy, science-teaching outcome expectancy, and the variables of experienced community of practice, which have been identified as: (a) open communication, (b) shared vocabulary, (c) remembering from previous lessons, and (d) learning from each other. As outlined in Chapter 3, STEBI-A (Riggs & Enochs,

1990) was used to measure personal science efficacy beliefs and science-teaching outcome expectancy, and the eCoP Instrument (Cadiz et al., 2009) was used to measure an individual's engagement in a community of practice.

Research Question 1 and Hypothesis 1. The first part of Research Question 1 asked if there was any relationship between the experience of community of practice and personal science-teaching efficacy (PSTE). The PSTE mean scores were relatively high (M = 56.77 with a standard deviation [*SD*] of 7.66) and ranged from 30 to 65 with a maximum possible score of 65 (see Table 3). The eCoP means scores were also relatively high (M = 71.47) and ranged from 44 to 84, with the maximum possible score of 84. A Pearson correlation test was performed to determine if there was a relationship between community of practice experiences and PSTE. It was hypothesized that there would be a significant relationship between experience of community of practice and PSTE. The Pearson correlation test findings generated ($r = .364$; $p = .0245$). The p value of the test was lower than 0.05; the null hypothesis is rejected at an alpha of 0.05. Therefore, the results show there is a significant linear statistical relationship between the teachers' experiences in community of practice and PSTE. (See Table 3.)

The second part of Research Question 1 asked which dimensions of community of practice had the greatest effect on PSTE. It was hypothesized that the dimension of "learning from each other" measured by eCoP would have the greatest effect on PSTE. After running the Pearson correlation test, the findings were as follows: ($r = .100$; $p = .550$). The p value was greater than 0.05, therefore the null hypothesis is accepted. Therefore, the results show the dimension, "learning from each other" did not have a significant statistical relationship with the teachers' PSTE. (See Table 3.)

Table 3

Personal Science-Teaching Efficacy (PSTE)

Respondent characteristics	N	% / mean (SD)	Study hypothesis
Personal Science-teaching efficacy (PSTE)	*44*		
Overall score	39	56.77 (*7.66*)	Hypothesis 1
I am continually finding better ways . . . (item 2)	44	4.18 (*0.81*)	
Even when I try very hard . . . (item 3)	44	1.61 (*0.87*)	
I know the steps necessary . . . (item 5)	44	4.02 (*0.98*)	
I am not very effective monitoring . . . (item 6)	44	2.25 (*1.10*)	
I generally teach science ineffectively (item 8)	43	1.63 (*0.82*)	
I understand science concepts . . . (item 12)	42	4.5 (0.74)	
I find it difficult to explain to . . . (item 17)	44	1.48 (*0.59*)	
I am typically able to answer . . . (item 18)	44	4.45 (*0.85*)	
I wonder if I have the necessary . . . (item 19)	42	1.69 (*1.11*)	
Given a choice, I would not invite . . . (item 21)	42	1.83 (*1.12*)	
When a student has difficulty . . . (item 22)	43	1.56 (*0.83*)	
When teaching science, I usually . . . (item 23)	42	4.74 (*0.63*)	
I don't know what to do . . . (item 24)	43	1.84 (*0.81*)	

A regression model was employed to adjust for the effect of potential confounders: gender, community setting, face-to-face teaching experience, and online teaching experience. We tested for normality, linearity, and homoscedasticity. The initial regression analysis showed a violation of the normality assumption (Shapiro-Wilk $W = 0.836$; $p = 0.000$). Some outliers were also detected. To test for homoscedasticity a Breusch-Pagan / Cook-Weisberg test was used. No heteroscedasticity was detected ($F = 2.06$; 0.160), and VIF values did not indicate presence of collinearity. Due to the violation of normality, a robust regression model for PSTE and eCoP was estimated. Results showed a positive linear relationship between PSTE and eCoP after adjusting for potential confounders ($B = .333$; $p = 0.005$). Female also showed a positive significant relationship with PSTE ($B = 5.142$; $p = 0.028$).

Research Question 2 and Hypothesis 2. The first part of Research Question 2 asked if there is a relationship between the experience of community of practice and science outcome teaching expectancy (STOE). The STOE mean score reported was 38.13 with a standard deviation of 6.82 with a possible overall score of 60 (see Table 4). As mentioned earlier, the eCoP scale maximum possible score is 84; the mean score for the responses was relatively high (M = 71.47; SD = 8.81). It was hypothesized that there would be a significant relationship between community of practice experiences and STOE. A Pearson correlation test resulted in findings showing (r = .438; p =. 0008). With an alpha level of .05, we reject the null hypothesis, and report that the results show there is a significant statistical linear relationship between the teachers' experiences in community of practice and science-teaching outcome expectancy. (See Table 4.)

The second part of Research Question 2 asked which dimensions of community of practice had the greatest effect on STOE. It was hypothesized that the dimension of "learning from each other" measured by eCoP would have the greatest effect on STOE. After running a Pearson correlation test, the findings were: (r = .351; p = .031). With an alpha of .05, the null hypothesis is rejected. Therefore, the results show the dimension "learning from each other" did have a significant statistical relationship between the teachers' experiences and their science-teaching outcomes (see Table 5).

Table 4

Science Teaching Outcome Expectancy (STOE)

Respondent characteristics	*N*	% / mean (*SD*)	Study hypothesis
Science-teaching outcome expectancy (STOE)	*44*		
Overall score	39	38.13 (*6.82*)	Hypothesis2
When a student does better . . . (item 1)	43	3.35 (*0.97*)	
When the science grades of students . . . (item 4)	44	3.36 (*0.89*)	
If students are underachieving in . . . (item 7)	44	2.54 (*0.98*)	
The inadequacy of a student's . . . (item 9)	44	3.41 (*0.95*)	
The low science achievement child . . . (item 10)	44	3.59 (*0.92*)	
When a low achieving child . . . (item 11)	43	3.51 (*0.83*)	
Increased effort in science teaching . . . (item 13)	43	2.81 (*1.05*)	
The teacher is generally responsible . . . (item 14)	43	3.09 (*0.81*)	
Students' achievement in science . . . (item 15)	44	3.23 (*0.91*)	
If parents comment that their child . . . (item 16)	42	3.67 (*0.65*)	
Effectiveness in science teaching . . . (item 20)	43	2.67 (*1.04*)	
Even teachers with good science . . . (item 25)	43	2.93 (*1.12*)	

Table 5

Person Correlation between PSTE/STOE and eCop Dimensions

	PSTE		STOE	
eCop	*r*	*p**	*r*	*p**
Overall	.364	.024	.438	.008
Open communication	.283	.080	.242	.138
Shared vocabulary	.425	.007	.237	.146
Previous lessons	.248	.128	.417	.010
Learning from each other	.100	.550	.351	.031

Note: p value corresponding to the test with null hypothesis ($r = 0$)

A regression model was employed to adjust for the effect of potential confounders: gender, community setting, face-to-face teaching experience, and online teaching experience. We tested for normality, linearity, and homoscedasticity. The Shapiro-Wilk test for normality was accepted. ($W = .980$; $p = .772$). To test for homoscedasticity a Breusch-Pagan / Cook-Weisberg test was used, and no heteroscedasticity detected ($F = 1.92$; $p = 0.1654$). The regression model showed a significant effect between STOE and eCoP (B = .482; 0 = 0.007). The other regressors were not significant.

Demographic Analysis

Bivariate analysis was used to identify relationships between gender, geographic area, and teaching experience and PSTE and STOE. Since there was a small sample, Mann-Whitney Wilcoxon was used. The Mann-Whitney Wilcoxon rank-sum test is a nonparametric test equivalent to the student t-test. According to the t-test, there were no statistically significant differences between male and female, at $z = 1.831$; $p = 0.0671$ for the variable PSTE. There were no gender differences in STOE scores, $z = -0.113$; $p = 0.9098$. A student t-test was used to compare rural and nonrural teaching communities, and no significant differences were found for PSTE ($t = -0.8476$). There was a low statistically significant difference between rural and nonrural teaching communities for STOE ($t = 0.0541$). The t-test shows significant differences in the mean of eCop scores between teachers with fewer than five years of online teaching experience and teachers with five or more years of online teaching experience ($t = 2.4902$; $p = .00173$). Furthermore, teachers with fewer than five years experience in online teaching scored higher in the "remembering previous lessons" dimension ($t = .0033$). The Mann-Whitney Wilcoxon score was consistent with the findings ($z = .0073$). Teachers with fewer than five years of online experience scored higher in "learning from each other" dimension ($t = .0081$). The Mann-Whitney Wilcoxon score was consistent with the findings ($z = 0.0322$).

Summary

This chapter presented the results from the study that examined the relationship between the experiences for teachers in online classrooms in a community of practice and their science-teaching efficacy beliefs. The hypothesis tested found that there was a significant relationship between experiences within a community of practice and personal science efficacy beliefs. Furthermore, there was a significant relationship between experiences within a community of practice and science-teaching outcome expectancy. In addition, the dimension of "learning from each other" in a community of practice had a significant relationship between science-teaching outcome expectancy. The implication for these findings and recommendations for future research will be discussed in Chapter 5.

Chapter Five: Summary

Initiatives to improve student learning in science have been the focus of education reform (Bybee, 2014; NSB, 2012). These policy goals aim to increase student achievement and raise the international ranking of U.S. students in science from the middle to the top in the next decade (NSB, 2012). These reforms emphasize teacher's professional development as one the main factors in influencing students' achievement.

To improve teacher quality, professional development activities have focused on teachers' communities of practice (Feiman-Nemser, 2001; NSB, 2012). Researchers have found communities of practice that focus on teacher collaboration and continuity have a positive effect on teaching efficacy and student achievement (Akerson et al., 2009; Liu et al., 2010; Vescio et al., 2008). Chase et al. (2001) found that teacher efficacy increased when they are involved in an active community of practice, which consists of new teachers, experienced teachers, administrators, mentors, and faculty teacher educators who met to reflect on their practices on a regular basis.

In recent years, virtual schools have become more prevalent in the United States (Mangieri, 2008) and are now considered a legitimate method to deliver key instruction and a part of the everyday landscape for education (Strother, 2002). With the rapid growth of virtual schools, it is important to examine science-teaching efficacy beliefs as they pertain to teachers. Because teachers in these virtual schools are held to the same teaching standards as teachers in traditional schools, it was beneficial to examine their community of practice experiences and how these experiences affect their science-teaching efficacy and student outcomes. This study explored the relationship of community of practice for science teachers in virtual K–12 schools with their teaching efficacy and student outcome expectations. The following section summarizes the results.

Summary of Findings

The purpose of this study was to examine whether K–12 teachers teaching in a virtual school experience a community of practice in science education and how that experience affects personal science-teaching efficacy (PSTE) and science-teaching outcome expectancy (STOE). The study is rooted in theoretical frameworks from Lave and Wenger's (1991) community of practice and Bandura's (1977) self-efficacy beliefs.

The present study used the SPSS statistical program for analyzing data. Listed below are the research questions and hypotheses for each.

R1: What is the relationship between experiences of community of practice and personal science-teaching efficacy (PSTE)? Which dimensions of experience in community of practice have the greatest effect on PSTE?

H1: There will be a significant relationship between experiences of community of practice and PSTE. The dimension of "learning from each other" measured by the Experienced Community of Practice Scale (eCoP) instrument will have the greatest effect on PSTE.

R2: What is the relationship between experiences of community of practice and science-teaching outcome expectancy (STOE)? Which dimensions of community of practice experiences have the greatest effect on STOE?

H2: There will be a significant relationship between community of practice experiences and STOE. The dimension of "learning from each other," measured by Experienced Community Of Practice (eCoP) instrument (Cadiz et al., 2009), will have the greatest effect on STOE.

The independent variable is community of practice experiences, which will be measured by the eCoP (Cadiz et al., 2009). The independent variables as measured by the eCoP scale are open communication, shared vocabulary, remembering previous lessons, and learning from each other. The dependent variables are PSTE and STOE, measured by the Science-Teaching Efficacy Beliefs Instrument-A (STEBI-A) (Riggs & Enochs, 1990).

Experienced Community of Practice and Personal Science Efficacy Beliefs. The research findings found a positive correlation between a teacher's experiences in a community of practice and PSTE, which supports Hypothesis 1. As presented in Chapter 4, surveyed teachers with higher scores on the eCoP reported to having a higher sense of PSTE ($M = 56.77$; $SD = 7.66$). In addition, the reported eCoP scores were relatively high ($M = 71.47$; $SD = 8.81$). The results show that there is a significant statistical relationship between the teachers' experiences in community of practice and their personal science-teaching efficacy. However, the second half of Hypothesis 1 was not supported as there was no significant correlation between PTSE and the dimension "learning from each other" in the eCoP scale. However, the dimension "shared vocabulary" ($p = .007 < .05$) was positively correlated with personal science efficacy beliefs.

Personal science-teaching efficacy belief is the level of confidence a science teacher has in his/her ability to successfully teach science. The PSTE scores recorded in this study were fairly high, which may be because science was the primary subject taught by the majority of respondents ($M = 64\%$). Furthermore, a high percentage of teachers who took part in the study (43%) have 5 to 10 years of experience teaching in face-to-face settings, and 19 participants have more than 10 years of face-to-face teaching experience (34%). It can be asserted that the PSTE scores of the teachers who took part in this study were high because of their content knowledge and teaching experience. High PSTE scores were consistent with other research (Lakshmanan et al., 2011; Posnanski, 2002; Ramey-Gassert et al., 1998). The teachers' overall high PSTE scores in this study may explain why there was no strong correlation between those scores and the dimension "learning from each other." The teachers who participated in this study may already have high levels of content knowledge and confidence in their ability to teach science and so may feel less inclined to need to "learn from each other" in a community of practice.

The eCoP scores for the teachers who participated in the study were also relatively high, so it can be asserted that they do experience a strong connection to a community of practice. According to Lave and Wenger (1991), a community of practice functions by sharing tools, routines, symbols, and vocabulary to accumulate knowledge. The strong relationship between "shared vocabulary" and PSTE ($p = .007 < .05$) is aligned with Lave and Wenger's community of practice theoretical framework. A community of practice creates a "common lingo" (Cadiz et al., 2009) to interact with each other and facilitate transfer of knowledge. Cadiz et al. add that a "shared vocabulary may be a way for a group to establish sense of exclusivity" (p. 1041). They further suggest that having this exclusivity adds value and motivation for interaction within a community of practice. While teachers in virtual schools have common science vocabulary with teachers in traditional brick-and-mortar schools, they also rely heavily on technology, which has created a new vocabulary concerning the transfer of knowledge and communication. Teachers in virtual schools rely on technology as a primary means of communication with their students, so that in online teaching, technology skills are vital in order to transmit content knowledge to students (SREB, 2009). The use of different communication tools and curriculum may lead science teachers in virtual schools to experience a strong need to utilize their "lingo" to effectively exchange knowledge. Thus, the strong correlation in this study between PSTE and the eCOP dimension "shared language" may demonstrate a unique exclusivity and connection to a community of practice for teachers in virtual schools.

Experienced Community of Practice and Personal Science Efficacy Beliefs. The research noted a positive correlation between a teacher's' experiences in a community of practice and STOE. Surveyed teachers reported overall lower STOE scores compared to their PSTE scores (M = 38.13; SD = 6.82). However, the average score was slightly above the midpoint of the STOE scale (which ranges from 12 to 60). Lower STOE scores compared to PSTE scores were consistent with numerous research findings (Lakshmanan et al., 2011; Posnanski, 2002; Ramey-Gassert et al., 1998).

Science-teaching outcome expectancy is the belief a science teacher has that effective science-teaching will influence his/her students. The lower STOE scores noted in this study might suggest that the virtual learning environment affects a teachers' confidence about influencing students. Hawkins, Graham, and Barbour (2012) found that teachers in virtual schools felt isolated and disconnected from their traditional role as teachers. Since these teachers are not able to physically work with students in a traditional setting, they may feel less effective in directly influencing students. Ramsey-Gassert et al. (1998) found that external factors influencing teachers' STOE scores were variables related to student motivation, school, and workplace, and parents and community. These variables were considered "barriers" to science-teaching. Teachers with lower ranges of STOE scores expected these "barriers" to affect their effectiveness as a science teacher (Ramey-Gassert et al., 1998). They further add that students' motivation and family variables were related to STOE but did not influence effective science-teaching (PSTE).

The present study found that student motivation is a strong variable that influenced participants' STOE scores. Students who attend school virtually must learn to self-regulate their learning autonomously. However, research found that students in virtual schools often lack the ability to master their own learning through self-regulation and self-discipline (Cavanaugh, Barbour, & Clark, 2009; Murphy & Rodriguez-Manzanares, 2009; Rice, 2006). Education research suggests that teachers in traditional classrooms play a vital role in motivating students who are less likely to have intrinsic motivation, but teachers in virtual schools may not be able to supply that motivation for their students, which may suggest why teachers in virtual schools reported having a lower STOE.

Teachers in virtual schools may also feel more isolated and less in control of their external factors, and therefore, may report a lower STOE. However, as mentioned in the previous section, the eCoP scores for teachers participating in this study were relatively high (M = 71.47; SD = 8.81). The results show a significant statistical relationship between the teachers' reported eCoP scores and their expected outcomes in science-teaching. There was a significant correlation between the reported STOE scores and the dimension "learning from each other" in the eCoP scale ($p = .031 < .05$). The dimension "learning from each other" has a positive influence on teachers' STOE because teachers may leverage their chances to learn from each other to mediate learning within a virtual learning environment. Teachers in virtual settings may feel isolated from their traditional role (Hawkins et al., 2012) and can benefit from a community of practice (White, 2010). White suggests that isolated practitioners can still create communities to share knowledge, connect, communicate, learn, and support each other. The high eCoP scores and positive relationship between "learning from each other" suggests that teachers who participated in this study may be leveraging their learning experiences in the virtual teaching environment in order to overcome the external "barriers."

Summary. The main hypotheses tested in this study were supported as significant relationships were found between experiences within a community of practice and personal science efficacy beliefs and science-teaching outcome expectancy. In addition, as predicted in Hypothesis 2, the eCoP dimension "learning from each other" had a significant relationship to science-teaching outcome expectancy. However, that dimension did not have a significant relationship to the participants' beliefs in their personal science-teaching efficacy, unlike what was predicted in Hypothesis 2.

The results showed a significant linear statistical relationship between the science teachers' experiences of community of practice and personal science-teaching efficacy. In addition, the study found that there was also a significant linear statistical relationship between teachers' community of practice experiences and science-teaching outcome expectancy. The results from this study were aligned with numerous studies that found that higher teaching efficacy leads to more effective science-teaching and higher student achievement (Lumpe et al., 2012; Sinclair et al., 2010). Past research has shown that long-term professional development that includes hands-on experience, scientific experts, master teachers, and experiential applications are positively correlated with teacher content knowledge, teacher science efficacy, and time spent teaching science (Lumpe et al., 2012; NRC, 1996).

Research Implications

The present study found a positive correlation between experiences in a community of practice for teachers in virtual classroom settings and their science efficacy beliefs. The majority of the teachers who participated in this study attended initial professional development

(*M* = 86%), mandatory professional development (*M* = 83%), informal professional development (*M* = 56%), and participated in supported mentorship relationships (*M* = 56.%). While overall eCoP scores were high (*M* = 71%), ongoing collaboration among members was reported as low (*M* = 5%). The results indicate a need for continuing professional development, which should focus on online science-teaching pedagogy, practice, and content.

The virtual teaching environment creates a "barrier" that may affect teachers' confidence in their students' outcomes. Yoon et al. (2006) found that science teachers' self-efficacy beliefs had a strong influence on their ability to successfully implement new science curriculum and choose the best instructional practice for effective teaching. Because teachers in this study reported lower levels of confidence in their students' outcomes (STOE scores: *M* = 38%), the data suggest that it would be beneficial for school leaders to create a formalized, structured training program, which includes mentorships, formal and informal learning opportunities, and professional time for teacher reflections to increase their science-teaching outcome expectancy. Furthermore, these learning opportunities will increase the community of practice experiences, which may help teachers feel less isolated and reduce external "barriers" to high student outcomes.

The release of the Next Generation Science Standards (NGSS) in April 2013 calls attention to education reforms needed at the national, state, and local levels (Bybee, 2014). The NGSS calls for dramatically reformed science curriculum (NGSS Lead States, 2013). As a result, there are education shifts that teachers must learn in order to successfully implement the NGSS. Such a change in science curriculum may affect their science-teaching efficacy beliefs.

Findings from the present study suggest that school leaders need to provide more opportunities for ongoing science content knowledge training and to maintain an active community of practice in for teachers who teach science in a virtual environment. Palmer (2011) found that teachers who participated in science professional development reported increased PSTE. In order to become successful in implementing the reformed science curriculum, Palmer recommends that professional development include out-of-school experiences, workshops, mentorships, and apprenticeships with science experts. Because the main science reform shift is in engineering, administrators for virtual schools can invite engineers to participate in the professional development or pair teachers with engineers. In essence, school leaders can provide more opportunities for science teachers in virtual settings to participate in their communities of practice.

Researchers have found communities of practice that focus on teacher collaboration and continuity have a positive effect on teaching efficacy and student achievement (Akerson, Cullen, & Hanson, 2009; Fazio, 2009; Liu, Lee, & Lin, 2010; Vescio et al., 2008). Chase et al. (2001) found that efficacy increased when teachers are involved in an active community of practice, which consists of new teachers, experienced teachers, administrators, mentors, and faculty teacher educators who meet regularly to reflect on their practices. As mentioned in the previous section, results from this study indicated that experiences in a community of practice were correlated to the science-teaching efficacy beliefs of teachers for virtual schools. School leaders, administrators, and policymakers should create a holistic professional development program for such teachers. The program should include training and development of new teachers, continual ongoing professional development for in-service teachers, peer coaching, apprenticeship with experts, and encouragement for teachers in virtual settings to maintain an active community of practice.

Limitations and Considerations

The present study has several limitations. First, the responses were gained through a sample of convenience, and because the sample consists of teachers teaching science in a virtual setting, the study's findings cannot be generalized to the entire population of science teachers. In addition, the response rate was relatively low ($N = 58$). Bryman (2008) writes:

> The key point is to recognize and acknowledge the implications of the possible limitation of a low response rate. On the other hand, if your research is based on a convenience sample, ironically it could be argued that a low response rate is less significant. (p. 220)

Since the present study was gained through a sample of convenience, the response rate is not as important as it would be if the population were nonrandom. Several reasons may be responsible for the survey's low response rate, including the fact that the survey was lengthy (37 questions with multiple-choice answers). The survey takes about 30 minutes to complete, and unfortunately, teachers received this survey at the end of the school year, a time when they are focused on state proficiency testing, report cards, and preparing to end the school year.

In addition, there were no incentives given to teachers to participate in the study. Researchers have found that the use of incentives significantly increases participation and the tendency for respondents to complete surveys (Bosnjak & Tuten, 2003; Deutskens, Ruyter, Wetzels, & Oosterveld, 2004; Sánchez-Fernández, Muñoz-Leiva, & Montoro-Ríos, 2012). Fan and Yan (2010) also reported that measures that take thirteen minutes or less to complete are ideal for influencing good response rates. Unfortunately, the combination of three instruments in this study created a long survey. The STEBI-A and eCoP remain valid survey instruments; however, for future research, incentives should be given to participants in order to increase response rates and likelihood of survey completion.

Second, the demographic study revealed that participants who completed the surveys are a homogenous sample consisting mostly of females (80%) teaching in a suburban (78%) setting. Therefore, the findings of this study cannot be generalized to the full population of science teachers as factors such as gender, age, and years of teaching science have been demonstrated to affect science efficacy beliefs (Angle & Moseley, 2009; Ramsey-Gassert et al., 1998). It would be beneficial for future research to examine a larger, more diverse sample in order to yield responses that may be used to generalize how experience of community of practice affects teachers’ science efficacy beliefs and outcomes.

Third, the present research is only examining correlations between variables; therefore the data cannot identify causation. While the present research found a positive linear relationship between teachers’ experiences within a community of practice and their beliefs about science-teaching efficacy and student outcomes, we cannot conclude that a community of practice was directly responsible for their scores. A qualitative approach may be useful in better understanding the dynamics between community of practice and efficacy beliefs.

Fourth, the present study utilized surveys to collect data. For this dissertation study, the surveys were the most efficient and cost-effective way to collect data, and the instruments used have demonstrated reliability and validity. But self-reporting can be problematic as there may be social desirability bias. In addition, another limitation is self-selection, there is a reasonable likelihood that teachers who participated in the study were more involved in the community of practice and may have higher personal science efficacy beliefs, which may skew the findings. Also, the measures used to gauge experiences of community of practice are relatively new; therefore, repeated studies utilizing the measures are recommended

Future Research

Possible future research could examine the virtual teaching environment through a mixed-method approach. While quantitative research provides useful data to understand the relationship between community of practice experiences and science efficacy beliefs, qualitative research can provide a deeper understanding of why teachers for virtual classrooms hold their efficacy beliefs and what experiences they have in communities of practice. Since the researcher did not ask open-ended questions, there are future opportunities to explore the relationship between communities of practice and science-teaching efficacy beliefs through both surveys and interviews.

In addition, longitudinal research would be useful in providing a more comprehensive understanding of the beliefs and experiences of science teachers for virtual schools. Since the present research collected data for one snapshot of those teachers' beliefs and experiences, it may not be an accurate representation of their average science-teaching practices. While the instrument asked participants for their "typical" and "average" beliefs and experience, teachers may respond differently in the beginning of the year compared to the end of the year. A longitudinal research study could provide a pre- and post-school-year comparison of eCoP and STEBI-A scores. This data may provide school leaders and stakeholders with information to help them implement, improve, and modify professional development activities in order to enhance the confidence and outcomes for science teachers in virtual settings.

With the rapid growth of virtual schools, it might be beneficial for other virtual learning communities to replicate the study. Because the present study examined only one education management organization, data cannot be generalized to the entire population of teachers in virtual settings. It would be beneficial for future research studies to examine a larger sample size to see if the results are similar to those in this study. Furthermore, since teachers in virtual settings reported to having a lower STOE for this present study, it may be beneficial to examine a hybrid online program and traditional online program. The comparative study may provide useful data that could be used to design training programs and ongoing professional developments for those types of schools. In addition, future research can examine teachers with less experience in the science-teaching community; there may be implications that teachers with less experience may be more likely to rely on their community of practice to learn from each other.

Conclusion

The goal of this study was to examine the relationships between the experiences within a community of practice for teachers in virtual schools and their science-teaching efficacy beliefs. With the rapid growth of virtual schools, the roles and responsibilities of teachers in those schools are quickly evolving. In this study, it has been shown that community of practice experiences for science teachers in virtual settings are positively correlated with higher ratings of science-teaching efficacy skills. These results provided insights about those teachers’ experiences with communities of practice, which may lead to improvements in student science achievement for their students. In addition, the study added to the understanding of how factors within a community of practice could affect the science-teaching efficacy of teachers in virtual settings. It is imperative that school districts, administrators, and stakeholders in the success of instructional strategies examine and develop professional learning opportunities to support teachers in virtual K–12 settings.

In conclusion, results of this study indicate a need for school leaders and stakeholders to create professional development programs that are grounded in social constructivist theoretical frameworks. The results from this study are in line with numerous research studies that have found that teachers who are involved in a community of practice report higher science-teaching efficacy beliefs (Fazio, 2009; Lakshmanan et al., 2011; Liu et al., 2010; Sinclair et al., 2010). School leaders should create programs that: (a) are long-term; (b) are offered continually; (c) are collaborative and involve activities between teachers, peer coaches, and school leaders; (d) create partnerships with science expert practitioners; (e) utilize professional development activities that are rooted in developing science self-efficacy beliefs; (e) promote the use of social networking sites to support the community of practice; (f) include opportunities for teacher self-reflection. In addition, leaders need to collect and obtain STEBI-A and eCoP reflections on a quarterly basis to analyze the effectiveness of professional development programs, which can help school leaders assess and analyze the effectiveness of the ongoing programs.

Future research will add to a growing body of knowledge related to teachers' science-teaching efficacy beliefs and of virtual teaching settings. That research can lead to improvements in science-teaching efficacy beliefs, student achievement, professional development, and community of practice experiences for teachers, and to ideas about the development of better science-inquiry curricula.

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Appendix A

Permission from Dr. Mangieri

From: [redacted]

Sent: Wednesday, June 05, 2013 6:20 AM

To: [redacted] (student)

Subject: Re: Demographic Survey

Yes, Phuong, you have my permission to use and modify my demographic survey from my dissertation.

Thank you,

[redacted]

Appendix B

Demographic Questions

1. Indicate the community setting for your online teaching position:
    a. Suburban
    b. Urban
    c. Rural

2. Indicate your years of face-to-face teaching experience:
    a. Less than one year
    b. One to four
    c. Five to nine
    d. More than ten

3. Indicate your years of online teaching experience:
    a. Less than one year
    b. One to four
    c. Five to nine
    d. More than ten

4. Indicate the primary content area for your online teaching position with the education management company:
    a. English
    b. Math
    c. Science
    d. Social science
    e. Foreign language
    f. Elective

5. Identify the types of professional development for online teaching you have received (select all that apply):
    a. Initial training for online pedagogy
    b. Initial training for technology such as course management system (CMS)
    c. Supported mentorship
    d. Mandatory formal online professional development workshops
    e. Optional formal professional development workshops
    f. Informal professional development (such as reading relevant books and journal articles, participating in chat groups or discussion forums aimed at online teachers)

6. Enter the grade level/levels in which you are teaching science: ____

7. Please provide the following personal information (optional):
Gender:
    a. Male
    b. Female

Appendix C

Experienced Community of Practice (eCoP) Scale

Items

Open Communication

cop.1: I feel comfortable communicating freely with others in my technical specialty.
cop.2: In my technical specialty there is an open environment for free communication.
cop.3: It is easy to communicate with others in my technical specialty.

Shared Vocabulary

cop.4: My technical specialty has a unique vocabulary.
cop.5: There is a common understanding within my technical specialty of the words and meanings that are used within the technical specialty.
cop.6: People outside my technical specialty might have difficulty understanding the vocabulary members of my technical specialty use to talk about the technology.

Remembering Previous Lessons

cop.7: Collaborating with other members of my technical specialty helps me remember things that we have learned.
cop.8: Participating in meetings with members of my technical specialty helps me to remember things that we have learned.
cop.9: Lessons learned from past experiences shared within my technical specialty are easily remembered.

Learning From Each Other

cop.10: I interact with others in my technical specialty with the intention of learning from them.
cop.11: I learn new skills and knowledge from collaborating with others in my technical specialty.
cop.12: Learning is shared among members of my technical specialty.

Appendix D

Science-Teaching Efficacy Instrument-A (STEBI-A)

Science Teaching Efficacy Belief Instrument*

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA = Strongly Agree
A = Agree
UN = Uncertain
D = Disagree
SD = Strongly Disagree

1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	SA A UN D SD
2. I am continually finding better ways to teach science.	SA A UN D SD
3. Even when I try very hard, I don't teach science as well as I do most subjects.	SA A UN D SD
4. When the science grades of students improve, it is most often due to their teacher having found a more effective teaching approach.	SA A UN D SD
5. I know the steps necessary to teach science concepts effectively.	SA A UN D SD
6. I am not very effective in monitoring science experiments.	SA A UN D SD
7. If students are underachieving in science, it is most likely due to ineffective science teaching.	SA A UN D SD
8. I generally teach science ineffectively.	SA A UN D SD
9. The inadequacy of a student's science background can be overcome by good teaching.	SA A UN D SD
10. The low science achievement of some students cannot generally be blamed on their teachers.	SA A UN D SD
11. When a low achieving child progresses in science, it is usually due to extra attention given by the teacher.	SA A UN D SD
12. I understand science concepts well enough to be effective in teaching elementary science.	SA A UN D SD
13. Increased effort in science teaching produces little change in some students' science achievement.	SA A UN D SD
14. The teacher is generally responsible for the achievement of students in science.	SA A UN D SD
15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	SA A UN D SD
16. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.	SA A UN D SD
17. I find it difficult to explain to students why science experiments work.	SA A UN D SD
18. I am typically able to answer students' science questions.	SA A UN D SD
19. I wonder if I have the necessary skills to teach science.	SA A UN D SD
20. Effectiveness in science teaching has little influence on the achievement of students with low motivation.	SA A UN D SD
21. Given a choice, I would not invite the principal to evaluate my science teaching.	SA A UN D SD
22. When a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better.	SA A UN D SD
23. When teaching science, I usually welcome student questions.	SA A UN D SD
24. I don't know what to do to turn students on to science.	SA A UN D SD
25. Even teachers with good science teaching abilities cannot help some kids learn science.	SA A UN D SD

*In Riggs, I., & Knochs, L. (1990). Towards the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education, 74*, 625-637.

Appendix E

Correspondence With Education Management Company

March 7, 2014

To Pepperdine University Institutional Review Board:

The purpose of this letter is to inform you that I give [redacted] permission to conduct the research titled *Virtual School Teachers' Science Efficacy Beliefs: The Effects of Community of Practice on Science Teaching Efficacy* at [redacted] Inc.

Sincerely,

[redacted]

[redacted]

Director of Academic Services

[redacted]

Appendix F

IRB Approval

PEPPERDINE UNIVERSITY

Graduate & Professional Schools Institutional Review Board

April 16, 2014

[redacted]

Protocol #: E1113D05
Project Title: Virtual School Teachers' Science Efficacy Beliefs: The Effects of Community of Practice on Science Teaching Efficacy Beliefs

Dear Ms. [redacted]:

Thank you for submitting your application, *Virtual School Teachers' Science Efficacy Beliefs: The Effects of Community of Practice on Science Teaching Efficacy Beliefs,* for exempt review to Pepperdine University's Graduate and Professional Schools Institutional Review Board (GPS IRB). The IRB appreciates the work you and your faculty advisor, Dr. Sparks, have done on the proposal. The IRB has reviewed your submitted IRB application and all ancillary materials. Upon review, the IRB has determined that the above entitled project meets the requirements for exemption under the federal regulations (45 CFR 46 - http://www.nihtraining.com/ohsrsite/guidelines/45cfr46.html) that govern the protections of human subjects. Specifically, section 45 CFR 46.101(b)(2) states:

> (b) Unless otherwise required by Department or Agency heads, research activities in which the only involvement of human subjects will be in one or more of the following categories are exempt from this policy:
>
> **Category (2) of 45 CFR 46.101**, research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: a) Information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and b) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

In addition, your application to waive documentation of consent, as indicated in your **Application for Waiver or Alteration of Informed Consent Procedures** form has been **approved**.

Your research must be conducted according to the proposal that was submitted to the IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit a **Request for Modification Form** to the GPS IRB. Because your study falls under exemption, there is no requirement for continuing IRB review of your project. Please be aware that changes to your protocol may prevent the research from qualifying for exemption from 45 CFR 46.101 and require submission of a new IRB application or other materials to the GPS IRB.

A goal of the IRB is to prevent negative occurrences during any research study. However, despite our best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the GPS IRB as soon as possible. We will ask for a complete explanation of the event and your response. Other actions also may be required depending on the nature of the event. Details regarding the timeframe in which adverse events must be reported to the GPS IRB and the appropriate form to be used to report this information can be found in the *Pepperdine University Protection of Human Participants in Research: Policies and Procedures Manual* (see link to "policy material" at http://www.pepperdine.edu/irb/graduate/).

6100 Center Drive, Los Angeles, California 90045 ▪ 310-568-5600

Please refer to the protocol number denoted above in all further communication or correspondence related to this approval. Should you have additional questions, please contact Kevin Collins, Manager of the Institutional Review Board (IRB) at gpsirb@peppderdine.edu. On behalf of the GPS IRB, I wish you success in this scholarly pursuit.

Sincerely,

[redacted]

Chair, Graduate and Professional Schools IRB

cc: [redacted]

Appendix G

Teacher Informed Consent Screen

Title of Research: Virtual School Teachers' Science Efficacy Beliefs: The Effects Of Community of Practice On Science-Teaching Efficacy Beliefs Link

Investigator: Phuong Pham Uzoff, Pepperdine University

My name is Phuong Pham Uzoff, and I am a doctoral student at Pepperdine University. I am conducting my dissertation study regarding community of practice, science-teaching efficacy, and science teaching beliefs of virtual science teachers. As a teacher, I am well aware of how precious your time is, and I greatly appreciate your participation.

Before agreeing to participate in this research study, it is important that you read the following explanation of this study**. The research study is being conducted as a partial requirement of the doctoral program.** This statement describes the purpose, procedures, benefits, risks, discomforts, and precautions of the program. Also described are the alternative procedures available to you, as well as your right to withdraw from the study at any time. No guarantees or assurances can be made as to the results of the study.

Explanation of Procedures

You will be asked to complete a web survey that will take you approximately 30 minutes to complete.

Risks and Discomforts

There is minimal risk: the only potential risk identified with participation in this study will be the personal time you will invest in taking the survey. No compensation or medical treatments are available if injury occurs.

Benefits

There are no direct benefits from participation in this study; however, the benefits to the education profession may include a better understanding of how being part of a community of practice affects science-teaching efficacy and science teaching beliefs. It is hoped the results of this study can be used for professional development, collaboration, and instructional purposes.

Anonymity

All information and data collected during this study will be completely anonymous. No identifiable information about your identity will be collected in this study. The researcher will have access to the reported data, which will be kept in a password-protected file on an external hard drive for in a locked file cabinet to which only the researcher has access. All research materials will be kept for a period of **five** years and then destroyed.

Withdrawal Without Prejudice

Participation is voluntary and you may choose not to complete the study. There will be no penalty or loss of benefits if you decline or discontinue participation at anytime during the study.

Costs and/or Payments to Subject for Participation in Research

There will be no costs for participating in the research. Also, participants will not be paid to participate in this research project.

Questions

If you have any questions concerning the research you can contact [redacted]. You may also contact my dissertation chairperson, Dr. [redacted], Pepperdine University Graduate School of Education and Psychology, 6100 Center Drive, Los Angeles, CA 90045, [redacted]*@pepperdine.edu*. If you have any questions regarding your rights as a participant, please contact Chairperson of the Graduate and Professional Schools Institutional Review Board, Dr. [redacted] Pepperdine University, Graduate School of Professional Schools of Institutional Review Board, Pepperdine University, Graduate School of Education and Psychology, 6100 Center Drive, Los Angeles, CA 900045, [redacted]*@pepperdine.edu*.

Agreement

By clicking the survey web link below, you are acknowledging that you have read and understand what your study participation entails and are consenting to participate in the study.

Virtual School Teachers' Science Efficacy Beliefs: The Effects Of Community of Practice On Science-Teaching Efficacy Beliefs Link

After 2 weeks, a reminder note will be sent to you to complete and return the survey. Since this email will go out to everyone, I apologize ahead of time for sending you these reminders if you have complied with the deadline.

Appendix H

Permission from Dr. Enochs to use STEBI-A Instrument

From: [redacted]
Sent: Thursday, February 28, 2013 11:30 AM
To: Pham, Phuong (student)
Cc: [redacted]
Subject: Re: STEBI-A request for use

You certainly may use the instruments as presented in the publications. If you have further questions feel free to contact me.

[redacted]

Professional Address:

[redacted]
Professor Emeritus
Science and Mathematics Education

[redacted]
http://smed.science.oregonstate.edu/node/42

Appendix I

Reminder Email

Dear Teacher,

Recently you received an email with a link to a survey that requests your participation in a research study that I am conducting. This email is a follow-up reminder asking for your assistance in completing the web survey. If you have already completed the survey, please disregard this email.

Please click on the following link to complete the survey:

Virtual School Teachers' Science Efficacy Beliefs: The Effects Of Community of Practice On Science-Teaching Efficacy Beliefs Link

Thank you for your participation and support.

Sincerely,

[redacted]

Appendix J

Copyright Permission From Dr. Etienne Wenger-Trayner

Sent:

Tuesday, October 15, 2013 3:00 PM

To:

Pham, Phuong (student)

Dear Phuong Pham

Yes, you are welcome to use those graphs/figures.

Good luck with your dissertation.

[redacted]

Appendix K

Permission to Use Experienced Community of Practice Scale

PsycTESTS Citation:

Cadiz, D., Sawyer, J. E., & Griffith, T. L. (2009). Experienced Community of Practice Scale [Database record]. Retrieved from PsycTESTS. doi: 10.1037/t05787–000

Test Shown: Full

Test Format:

A 7-point Likert-type scale for each of the Experienced Community of Practice Scale items was utilized, anchored from 1 = *strongly disagree* to 7 = *strongly agree.*

Source:

Cadiz, David, Sawyer, John E., & Griffith, Terri L. (2009). Developing and validating field measurement scales for absorptive capacity and experienced community of practice. *Educational and Psychological Measurement,* 69(6),1035–1058. doi: 10.1177/0013164409344494, © 2009 by SAGE Publications. Reproduced by Permission of SAGE Publications.

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