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The Effects of Online Professional Development on Teacher Behavior and Perceptions of Science, Technology, Engineering, Art and Math Teaching Efficacy

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The Effects of Online Professional Development on Teacher Behavior and Perceptions of
Science, Technology, Engineering, Art, and Math Teaching Efficacy

Guray Joseph Taysever

Capstone Document Submitted in Partial Fulfillment of the Requirements
for the Degree of
Doctorate of Interdisciplinary Leadership

Governors State University

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Abstract

Background: Research shows that STEAM (science, technology, engineering, arts, and mathematics) curriculum improves student abilities to create relevant products and services. However, teacher support is critical when implementing a new, school-wide curriculum model and learning tools as teachers need easy access to online resources. Yet, online resources currently used in many schools do not inform the processes or the ideology of STEAM curricula through collaboration among all teachers in a private school setting.

Purpose: The focus of this quasi-experimental quantitative research study was to examine the impact of a 1-week online STEAM professional development course on teacher behavior and their perceptions of their self-efficacy regarding integrating STEAM concepts in their classroom instruction, lesson plans, and extracurricular activities. The setting was a private school (preschool through Grade 8) with a focus on science and math education in a large Midwestern city.

Methods: A quasi-experimental design was selected for this study because of the necessity for data that determine the relationship between the independent variable, which was the STEAM online course developed for the present study, and the dependent variable, which was the teachers' self-reported behavior and perceptions of their STEAM teaching self-efficacy before and after taking the online course. It was also necessary to generate data regarding the relationship between teachers participating in a 1-week online STEAM professional development course and their behavior and perceptions of their self-efficacy regarding STEAM teaching. The participants included elementary and preschool art, math, science, computer, language arts, and social studies teachers at a private school with a focus on science and math education in a large Midwestern city.

Results: It was hypothesized that the initiation of a 1-week online STEAM course for teachers would be effective, and pretest/posttest results supported this hypothesis. This is because the intervention combines easy online access to STEAM curricula with the understanding of the importance of the STEAM education model and concepts to all teachers in the private school setting.

Conclusion: Study results showed that online professional development participants had an overall positive perception of the effects of the course on their beliefs and perceptions regarding their STEAM curricula teaching self-efficacy. Differences in the pretest and posttest survey results showed that the STEAM online professional development impacted teachers' STEAM teaching self-efficacy.

Governors State University
Doctor of Interdisciplinary Leadership Program

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Chapter 1. Introduction to the Project

Science, technology, engineering, the arts, and mathematics (STEAM) subjects are hot topics in the United States according to business owners and educators. The U.S. business community has called for focusing on these subjects in preschool through eighth grade curriculum with the goal of preparing an active and globally competitive workforce. Since politicians and business leaders are concerned about the lack of qualified workers in science and engineering jobs, the idea of developing STEAM education curricula for prekindergarten (pre-K) through Grade 8 students has emerged (National Science Board, 2008).

Though much public discussion focuses on higher education and high school curricula, educators, business people, and policy makers are realizing that STEAM instruction has to start early to catch students' interest in sciences and engineering. However, it seems that many elementary and middle school teachers have difficulty teaching science, computer, and math topics due to lack of time, knowledge, and experience (Tenaw, 2014). Bybee (2000) stated that people are largely unaware of technology and engineering concepts, as well as their implementation in the educational setting, even though society deeply depends on technology and engineering. While technology develops rapidly, teachers' adaptation to this development remains slow because teachers' negative views of, beliefs in, and attitudes toward technology prevent implementation of technology in the education setting (Namlu, 2002). This lack of awareness of STEAM-related subjects also impacts teacher preparation programs

Teacher training programs emphasize pedagogical theories and some instructional methods. They do not include real-life activities, which STEAM curricula require. It is one of the key reasons why elementary school teachers have difficulty designing hands-on science, math, computer, technology, and arts activities. Developing these activities are even more

problematic for many newly graduated teachers who often do not have adequate experience in using computers in teaching-learning processes (Kurz & Middleton, 2006). According to Quigley (2016), STEAM teaching practices are new, and implementation of STEAM requires a change in pedagogical approach. Standardized instruction, schedules, and other prescribed practices are still common in schools and often prevent innovation from occurring (Cuban, Kirkpatrick, & Peck, 2001; Shaffer, 2006). It is very important to consider the abilities of teachers and identifying the context while making deep and consequential changes in their teaching practice (Quigley, 2016). Collaboration among administrators and science, math, arts, and computer teachers is also important for implementing a STEAM-oriented curriculum at the primary school level.

Not exposing students to STEAM concepts until late in elementary or in middle school leaves them ill-equipped to connect the concepts to such learning tasks as making a robot, writing a phone application, or learning computer coding. Having access to STEAM topics in early elementary school fosters development of creativity and adaptability in students. It also might spur their interest enough so that they may want to become inventors or scientists rather than only focusing on promotion to the next grade level or passing a test. I argue that introducing engineering as early as elementary school may provide student's opportunities to engage their creativity and promote a level of academic competence that has not been achieved in traditional science classrooms as they are currently structured.

Implementing a STEAM curriculum in each grade level and subject requires effective and ongoing professional development for delivering best practices and pillars of STEAM curricula to teachers. Since the STEAM curriculum is unique, it requires specially designed professional development in the school setting. Sparks (2002) noted that professional

development for teachers should be tailored to their specific needs and embedded in their daily lives. Further, Sparks argued that such programs should come with strong support from school administration. Based on pre- and posttest results of comfort, pedagogical discontentment, inquiry implementation, perceived efficacy, and content knowledge regarding STEM in 230 Grade 4–9 teachers who attended a 4-day residential summer institute on STEM, Nadelson, Seifert, and Moll (2012) concluded that the significant changes seen indicated that it might be beneficial to train teachers in STEM areas.

1.1 Statement of research problem

Implementing science, technology, engineering, arts, and math subjects in schools is vital in the 21st century because of the increasing number of new technological tools and new online curriculum and resources in the school communities. It seems difficult for teachers to keep track of fast-changing educational tools and resources while they cover the state standards for each topic. Many newly graduated teachers do not have adequate experience in using computers in teaching-learning processes (Kurz & Middleton, 2006). Watts-Taffe, Gwinn, Johnson, and Horn (2003) found that teacher preparation for technology integration was minimal. As such, professional development can play a critical role in preparing teachers for STEM- or STEAM - based education. On the other hand, there are many facets related to the development and delivery of effective professional development programs. These facets include: (a) research plans, (b) development of a philosophical focus, (c) identification of standards-based curriculum materials, (d) collaboration amongst STEM disciplines, (e) formulation of effective professional development models, (f) research specific to pedagogical content knowledge, and (g) general justification and promotion of engineering and technology education as a recognized part of K-12 education (Custer, Daugherty, Zeng, Westrick, & Merrill (2007). So, establishing an online

platform at the school through an administrator who is expert about STEAM curricula and teacher collaboration might help teachers learn and keep track of all these changes and implement them. As such, any online professional development that blends STEAM subjects with practice and applications might make it easier for teachers to create classes and lesson plans that reflect new resources and technology.

1.2 Statement of the purpose of the study

The present study's purpose was to investigate the impact of a 1-week online STEAM professional development course on teacher behavior and their perceptions of their self-efficacy regarding integrating STEAM concepts in their classroom instruction, lesson plans, and extracurricular activities. The study setting was a private school (preschool through Grade 8) with a focus on science and math education in a large midwestern city.

A quasi-experimental design was selected for this study because of the necessity for data that determined the relationship between the independent variable, the STEAM online course developed for the present study, and the dependent variable, the teachers' self-reported behavior and perceptions of their STEAM teaching self-efficacy before and after taking the online course. Data that determined a relationship between teachers participating in a 1-week online STEAM professional development course and their behavior and perceptions of their self-efficacy regarding STEAM teaching were also necessary. The study population was a nonequivalent group, which reflects experiments where existing groups are not divided so there is a single group.

I designed a 1-week online STEAM professional development course. Study participants included 30 teachers at the aforementioned private school. They were asked to take a pretest survey on their teaching behaviors and perceptions of their self-efficacy regarding STEAM

teaching prior to enrolling in the course and were administered a posttest survey on the same factors after they completed the course. Preassessment measurements provided baseline data for teachers' behaviors and perceptions prior to taking the online course, and postassessment measurements provided data reflecting the course's effectiveness on these behaviors and perceptions. I tested specific hypotheses through standardized means and calculated the resulting data through a specific statistical process of *t* test analyses and Wilcoxon signed-rank tests to determine the independent variable's influence on the dependent variable.

1.3 Statement of the significance of the study

STEAM curricula implementation requires every stakeholder, which includes teachers, administrators, board members, and policymakers, in the school setting to be a change agent teacher, administrator and policy maker, to be aware of recent technological, scientific and art-based topics. They should also try to find ways to teach the students and integrate their learning with the most updated knowledge. STEAM curricula provide opportunities for students to think outside of the box and to build and connect all the silos of STEAM curriculum, which are included under the topics of science, technology, engineering, the arts, and math.

Teachers play a critical role in delivering authentic curriculum design. As Piaget stated, What is needed at both the university and secondary level are teachers who approach it from a constantly interdisciplinary point of view, knowing how to give general significance to the structures they use and to integrate them into overall systems embracing the other disciplines with the spirit of epistemology to be able to make their students constantly aware of the relations between their special province and sciences as a whole. Such men are rare today. (Piaget, as cited in Martinez & Stager, 2013, p. 13)

To get educators to embrace STEAM curricula, which have a similar function as interdisciplinary teaching or constructivist ways, Martinez and Stager (2013) spoke highly about the fact that there should be a sample of the study or training model or practice available for teachers. Since the STEAM curriculum concept is very new, it is difficult to find available, affordable, and easily accessed training (Y. Kim & Park, 2012b; Yackman, 2007). As such, having access to well-designed online professional development about STEAM curricula may help teachers understand general practices of STEAM curricula.

Determining teachers' beliefs and motivation is important when testing the effectiveness of any professional development program and was also important for the present study.

Bandura's (1977) theory states that individuals' level of motivation, affective states, and actions are based more on what they believe than on what is objectively true. This theory was applied to the present study and guided my exploration of teachers' perceptions, attitudes, and beliefs regarding the online STEAM course developed for this study. The teachers' responses to this course resulted in understanding the effects of STEAM professional development delivered online. Online learning also attracted researchers to study the importance and effectiveness of online learning

Ally (2004) defined online learning as using the Internet to "access learning materials; to interact with the content, instructor, and other learners; and to obtain support during the learning process, in order to acquire knowledge, to construct personal meaning, and to grow from the learning experience" (p. 7). Anderson (2008) recommended to the online learning developers about any effective online portal that they should have a goal to apply all techniques and best practices in order to attract educators and teachers since there is no direct, face-to-face contact with the instructor, and the inclusion of the online materials should be applicable to all learners.

1.4 Statement of the research questions

The overall question developed to guide the present project was: To what extent would a STEAM-based online course help preschool through Grade 8 teachers better understand the importance of implementing STEAM-based activities in their classrooms, encourage teachers to be open to using new innovations in the education setting, and ultimately contribute to establishing a unique STEAM blended online course for all school communities? The research questions developed to guide the present study were:

- Research Question 1 (RQ1): To what extent would a 1-week STEAM online professional development course affect preschool through Grade 8 teachers' behaviors and perceptions regarding their self-efficacy for implementing STEAM-based activities in their classrooms and encourage teachers to be open to using new innovations in the education setting?

Null Hypothesis 1 ($H1_0$): A 1-week STEAM online professional development course for preschool through Grade 8 teachers will not significantly affect teachers' behaviors and perceptions regarding their self-efficacy for implementing STEAM-based activities in their classrooms and will not encourage teachers to be open to using new innovations in the education setting.

Alternative Hypothesis 1 ($H1_a$): A 1-week STEAM online professional development course for preschool through Grade 8 teachers will have a significant effect on teachers' behaviors and perceptions regarding their self-efficacy for implementing STEAM-based activities in their classroom and will encourage teachers to be open to using new innovations in the education setting.

- Research Question 2 (RQ2): To what extent is a 1-week STEAM online professional development course an effective tool for helping educators understand STEAM's general meaning and implementation in the schools?

Null Hypothesis 2 ($H2_0$): A 1-week STEAM online professional development course is not an effective tool for helping educators understand STEAM's general meaning and implementation in the schools.

Alternative Hypothesis 2 ($H2_a$): A 1-week STEAM online professional development course is an effective tool for helping educators understand STEAM's general meaning and implementation in the schools.

1.5 Definition of terms

This study includes some key words which constitutes the fundamental part of the study.

So these terms are as follows.

- **Blended learning** - Collis and Moonen (2001) defined blended learning is a hybrid of traditional face-to-face and online learning. Instruction takes place in the classroom and online, and the online component becomes a natural extension of traditional classroom learning.
- **Online learning** - Distance learning in which students and teacher are separated by distance and interact via the Internet (Barr & Miller, 2013).
- **Problem-based learning** - Problem-based learning is an instructional method characterized by three elements: problems, tutors, and students (Majoor, Schmidt, Snellen-Balendong, Moust, & Stalenhoef-Halling, 1990)

- **STEAM** - An educational approach to learning that uses science, technology, engineering, the arts, and mathematics as access points for guiding student inquiry, dialogue, and critical thinking (Riley, 2013).
- **STEM** - STEM is an acronym for science, technology, engineering, and mathematics. It may be defined as the integration of science, technology, engineering, and mathematics into a new cross-disciplinary subject in schools (Dugger, 2010).
- **Teacher professional development** - Processes and activities designed to enhance the professional knowledge, skills, and attitudes of educators so that they might, in turn, improve student learning (Guskey, 2000).

1.6 Statement of study limitations

For the proposed study, there are some limitations; these limitations might be included under the topics of sampled population, research method, and length of the professional development course and the researcher's role during this study. The sample came only from teachers who worked in the same school; future studies might be expanded to different schools and groups of teachers working in different school settings. The collected data might have strengthened study results. The research method might have been mixed methods through collecting interview responses, and, the 1-week STEAM-based online professional development could be more than 1 week so that participants could observe the online modules and responses of other participants. Finally, this study was conducted in a school where I was the principal, so the participants might feel like to be obligated to participate to this study. On the other six teachers did not want to participate to this study.

1.7 Summary of chapter

This study's focus was on exploring the impact of a 1-week STEAM-based online professional development course on teachers' perceptions of their STEAM teaching self-efficacy and beliefs about STEAM curricula. In Chapter 1, I introduced the study along with its purpose study and identified the theoretical framework. I presented the research questions formulated to guide the proposed inquiry, explained the significance of the study, the limitations of the study, and provided an overview of key terms that will be used throughout the study. In Chapter 2, I provide a review of the latest research related to STEAM curricula and its general practices and benefits. I also cover extant literature about teacher professional development, online professional development, and blended learning. In the last section of the literature review, I included extant literature indicating the reasons for implementing online STEAM-based professional development at the school setting.

In Chapter 3, I provide information about the methodology in sections on methodology, study sample, the survey instrument, and data analyses. In Chapter 4, I provide information about the study results, including tables, diagrams, and descriptive and statistical data, which is aligned to the hypotheses and research questions. Finally, I provide a discussion of study results, conclusions, and recommendations in Chapter 5.

Chapter 2. Review of the Literature

Despite the great benefit and success of STEAM, little research exists on what STEAM teaching practices are and how teachers enact those practices in their classrooms (Y. Kim & Park, 2012b; Yackman, 2007). Yet, there is a growing national attention towards STEAM. In fact, the NMC Horizon Report (2015) listed STEAM as one of the rising trends in K-12 education and STEAM-focused schools continue to appear in a variety of locales

Implementing a STEAM curriculum can start a new trend in schools regarding articulating and implementing multiple educational disciplines that reflect current trends in educational learning methods such as problem-based learning, project-based learning, cross-curricular teaching, and STEM education. Such implementation allows schools to connect with the larger community, including city officials, fire and police departments, artists, designers, scientists, engineers, and lawmakers. Schools that introduce different professions and careers to students can help students understand the main concept of each career and its connection with other careers. For example, any physician should be also a good physiologist, and a good plastic surgeon is also an accomplished artist/designer. Firemen know chemistry in order to protect themselves. STEAM-based curriculum simply brings real-life connections to learning and teaching.

STEAM-based curricula implementation is crucial for schools in order to create life-long learners and innovators. In today's world, new software applications are developed every day, so education must be shaped around newly emerging technologies. Adding the arts to STEM brings together the critical components of how and what and ties them together with why (Riley, 2014). For example, if students learn technology and programming, it will become easy for them to discover or design a new programming language for writing new software in the future.

Educators have been coming up with different educational tools, materials, and theories to make teaching and learning effective and help students be successful. Project-based learning, cross-curricular teaching models, problem-based learning, and the Montessori model of teaching are all effective, but implementing these programs requires significant effort, budget, and staff (Chief Editor, 2015). According to Yakman (2008), the STEAM educational model offers the best fit with every existing model or upcoming models and is backed by all of the major learning theories in curriculum disciplines, including constructivism and problem-based learning.

STEAM curriculum implementation can benefit schools by enriching the curriculum, even under circumstances surrounding evolving and/or ongoing lack of resources, and it integrates very smoothly with STEM-based curricula. Collaboration between art and computer teachers is necessary in 21st-century classrooms to smoothly integrate technology into art courses, and can be accomplished by adding such tools as 3-D printers or laser cutters. These new devices are added to art classrooms to help students discover their capacity for thinking about art through the lens of modern technology. The added benefit of the new devices and tools will be the opportunity for close collaboration between art and computer teachers and elementary teachers. School-wide projects are a great way to for teachers to work together in order for students to create and connect to real life with all delivered subjects.

Ideally, school leaders should create their own tools rather than buy them from other organizations. The school leaders' vision should allow staff and students to establish learning tools by themselves, which helps students to be creative and to understand the concept of the STEAM education model. In ancient times and without modern devices, human beings created their tools and resources through using their brain, talents, and skills. Their surroundings inspired their inventions; household or farming tools were made from plants and animal

products. Sadly, it might be concluded that people's creativity began diminishing once they became more highly civilized. Bringing back the potential for human creativity is possible through tools, resources, hands-on activities, and collaborative teaching methods in schools. A STEAM-based curriculum would fulfill the innate need of human beings to be creative again. Similarly, Martinez and Stager (2013) also stated that throughout history, arts and sciences, craft and engineering, analytical thinking, and personal expression have coexisted in communities, industry, culture, commerce, academia, and in the heads of creative people.

Meeting STEAM curricula expectations in the schools requires more teachers who are well trained and informed about STEAM. Collaboration and cross-curricular activities are an essential part of STEM curricula, so bringing all experienced teachers' knowledge about STEM or STEAM implementation depends on the administration role to establish a platform to get students to exchange information and learn from each other (Jackson, 2015)

2.1 What is STEAM?

STEAM is a contemporary movement to marry the arts with STEM. John Maede, director at the Rhode Island School of Design, started a national initiative to add arts and design to STEM education and research (Rhode Island School of Design, 2016). The principles driving STEAM are based in the belief that students need a natural and a creative view of the world to compete in the 21st century's global market (Sousa & Pilecki, 2013). STEAM education was derived from the STEM concept which promotes the integration of science, technology, engineering, and math into school curriculum that was publicly announced by the Obama administration in 2009, through the Educate to innovate campaign, and was designed to motivate and inspire students to excel in STEM subjects (Morrissey, 2010)

STEAM is a holistic curriculum design that allows school personnel and students to understand real-life related items, problems, innovations, and trends through applying an interdisciplinary learning process and techniques. In each grade level, students learn the standards in each subject area and combine them in understanding and analyzing real life (Yakman, 2008). Adding the arts gives children the opportunity to illustrate STEM concepts in creative and imaginative ways; express ideas about the world through music, visual arts, dance, media arts, and drama; communicate with descriptive language; illustrate ideas with crayons or markers; create graphs; and build models (Rabalais, 2014). For example, Eisner (1972) stressed that the prime value of the arts in education lies in the unique contributions it makes to the individual's experience with an understanding of the world.

Businesses support adding the arts to STEM education because organizations are experiencing major shifts in their conceptual models. Models have shifted from the perception of seeing organizations as machines, then to knowledge and knowledge flows. Finally, in the 21st century organizations are becoming mechanisms for creating complete and meaningful experiences (McGrath (2014). Having a workforce skilled in creating complete and meaningful experiences requires that the right brain and the left brain, responsible for motor skills such as working with computers, writing, basic drawing, and sequential building of devices, work effectively. Advanced technology will place more value on people who are right brain thinkers, who will be the problem solvers of the future. Drucker (2001) also categorized left-brain workers, such as physicians and engineers, as knowledge workers who get paid for putting to work what they learned in school rather than for their physical strength or manual skills.

Society in the 21st century will need citizens to solve world problems, including global warming, refugees, world poverty, and lack of educational opportunities. In order to have the

types of generations that can solve problems, more right-brain thinkers are needed who will be able to influence people through their art and their writings, people who can impact minds and thinking, such as leaders sensitive to social and economic topics related to diversity problems. As such, implementing STEAM is the best way to educate students and prepare them to be the motivational leaders of the future. Educators are realizing that STEAM curricula throughout K-12 education are extremely important for educating students and preparing them for new college degrees and innovating careers.

STEAM focuses on how the arts intersect and interact through science, technology, engineering, and mathematics. On the other hand, arts integration can be used broadly in any area and subject that contains a naturally aligned standard with the selected arts standard (Riley, 2014). STEM and the arts further students' intellectual development and prepare them for a futuristic way of life. STEAM encompasses all the essential components of the mind, heart, body, and spirit while students are engaged in innovative learning experiences. Through physical activities, they develop their physical part of their body and learn through their minds and are able to practice and implement all the subjects into their life using their emotions. As a consequence of this learning experience, students will feel appreciated and valued for their contributions to our society (Yakman, 2008). It might be summarized that a STEAM curriculum provides the opportunity for students to learn by being motivated about each subject they are learning and empowers them to use their full potential, which is needed for the citizens of the future.

2.2 Why does STEAM take place in the schools?

U.S. education has changed throughout history. Prior to the 17th century, there was no formal schooling in the United States (Resnick, 2004). Some families hired private tutors to

fulfill their children's need for an education. Later, district-based schooling was started. As it was based on a tax and levy system, education was controlled by the local districts and states. Historical trends and innovations fostered the educational system's progress and changes throughout history. Even though education was the responsibility of state officials, the U.S. presidents contributed to education initiatives through different acts and policies in order to help the nation become competitive with other countries (Kodrzycki, 2002).

The Sputnik launch, the Cold War, and other foreign wars fostered economic and technological advancement in the United States (Sousa & Pilecki, 2013). In 2007, the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (America COMPETES) Act was signed into law to ensure that innovation remained a priority in the 21st century. This act was reauthorized in 2010 in recognition of the continuing need to address STEM development in the United States. During President Barak Obama's first term, the President's Council of Advisors on Science and Technology (PCAST; 2010) recommended the creation of 1,000 new STEM schools over the next decade, including 200 high schools and 800 elementary and middle schools. More recently, PCAST recommended increasing the number of STEM college graduates by 1,000,000 by 2022 (PCAST, 2012). Part of PCAST's role in this initiative has been to identify clear goals and strategies for developing a STEM-literate citizenry and a STEM-proficient workforce.

Yakman (2008) stated that educational theorists have developed a number of school models and programs. Some of them include Bruner's contributions to cognitive learning with his theories of problem-based learning, Bloom's taxonomy of learning (Bloom, 1971), Gagne's principles of instructional design (Gagne, Wagner, Golas, & Keller, 2005) and Marzano's instructional strategies (Marzano, 2007). Educational media such Association for Supervision

and Curriculum Development publications, *Education Week*, and the Edutopia website have covered these theories. By doing so, they have acknowledged educators' efforts and shared information on the best exemplary school models, which has helped inspire initiates at other schools.

Improving the social justice of children in the United States and improving results of state standardized tests have been the main goals for the education sector and for education scholars. However, developing new educational theories and programs has not been enough to put U.S. schools at the top of world rankings. In terms of standardization at the schools, insisting that all students be treated the same way and that they all study the same subject at the same time in the same way is a strategy that denies reality since the lack of economic capital (income and wealth), social capital (neighborhood well-being), and cultural capital (a healthy, nurturing home environment) outside the schoolhouse is a critical factor in perpetuating the achievement gap between poor urban students and their affluent equivalents (Saatcioglu & Neilsen, 2006). It is akin to a physician stepping into a waiting room and giving a shot of penicillin to the assembled patients, but the prescription would not work for most of the patients and might actually harm some (Wolk, 2011). Inflexible, standards-based accountability does not work for most young people and harms some of them. Martinez and Stager (2013) also pointed out that majority of the schools are experiencing difficult time to offer education blended with the new tools and resources for the past few decades. The emphasis on high-stakes standardized testing, teaching to the test, deprofessionalizing teachers, and depending on data rather than teacher expertise has created classrooms that are increasingly devoid of play, rich materials, and the time to do projects. Parents higher in socioeconomic status avoided these issues by sending their children to private schools or magnet schools because, as Wells and Crain (1997) found, higher status

groups have greater cultural capital and fewer market constraints, which give them an advantage over the poor in a choice system. Sending children to magnet schools does not solve all education problems nationwide, but there will be great demand in the future for individuals who can work at engineering and STEAM-related jobs, so technology advancement requires more professionals who will be well-versed in STEAM subjects. Based on the data, current educational trends and governmental support and initiatives seem not enough to position U.S. elementary and secondary school systems as world leaders in education (Hanushek, Peterson, & Woessmann, 2012).

Over time, these movements caused much damage to children's education. In the United States in 2009, approximately 1,250,000 children, or about 7,000 students per day, left school without a high school diploma (Furger, 2008). In 2008, the Aerospace Industries Association of America reported that the United States was experiencing a chronic decline in homegrown STEM talent and was increasingly dependent on foreign scholars to fill the workforce and leadership voids. Dugger (2010) stated that in 2007 the total number of foreign citizens studying in the United States, including undergraduates, had passed the half-million mark. Worldwide, research indicated that in 2003, only 4% of U.S. College graduates majored in engineering compared to 13% of European students and 20% of Asian students (Dugger, 2010). These data support the idea that STEM occupations are growing due to the need for individuals with these skills. In 2005, a Business Roundtable report warned that if current trends continued, more than 90% of all scientists and engineers in the world would live in Asia. STEM education in the United States can help solve these problems in the future.

The achievement gap of students at the elementary and middle school levels is the focus of education reform. However, students should be more creative and innovative in addition to

getting good scores on state tests. They should also be exposed to more updated resources because the world, as well as education, technology, and student learning styles, have changed. Computers and new tools in the software and hardware business fostered changes in educational textbooks, materials, and resources. These changes caused people from other careers and educators to use, learn and create, and repair these new technological tools while they exposed any problems in school and classroom settings (Martinez & Stager, 2013).

Martinez and Stager (2013) also critiqued schools separating the teaching of the arts and science theory and practice, which does not fit today's world since each job category is also connected with another career; for example, architects are artists and craftsmen deal in aesthetics, tradition, and mathematical precision. Video game designers rely on computer science; engineering and industrial design are inseparable.

The U.S. education system should focus on the goal of educating and graduating more students who are innovators in order to compete with other nations (Wagner, 2012). The U.S. Department of Commerce has estimated that jobs in STEM fields will grow 17% by 2018, nearly double the growth for non-STEM jobs. By 2018, the United States will have more than 1,200,000 unfilled STEM jobs because there will not be enough qualified workers to fill them (Dugger, 2010). STEM is where jobs are today and where the job growth will be in the future.

2.3 Benefits of STEAM curricula implementation in the schools

Recent studies (Martinez & Stager, 2013; Riley, 2014; Yakman, 2008) give credit to STEAM implementation at the schools in different categories. These categories are not limited to only helping enhance students' development of cognitive and motor skills but also improving academic achievement and inspiring and exploring innovators in their early ages.

Creativity is one of the benefits of STEAM-based curricula. Adding the arts to STEM allows students and teachers to be creative, helps develop students' motor and cognitive skills, and tests students' capacities for performing and visual arts skills. Researchers have shown that creativity is often linked to the arts. For example, participating in art, music, drama, dance, poetry, etc., may provide more creative outlets for STEM students, serve as a viable recruiting tool for future students into technical fields, and help students derive joy from the learning experience (Welch, 2011). Business and school leaders see the arts as a key to preparing students to be creative workers for the global marketplace because creativity is the core element of innovation. The arts and their creative processes may allow students to explore and unlock multiple intelligences since everything occurring in one's environment is related to the arts. The arts have been an important part of every civilization: People proved themselves by building big temples with different motifs and characters on the walls, scientists competed to build the most interesting buildings, and poets and scholars competed with each other to share and talk about solving problems of the people in their time (Lucie-Smith, 1993).

Science has reflected the arts throughout history. It has changed according to the tools and resources that were developed throughout history. The arts sometimes were used to influence the ruling style of civilizations, and the arts sometimes influenced people's beliefs. In today's world most of the tourism in Europe, Asia, and other continents is based on visiting historical churches, cathedral, and museums. Today, art can be found everywhere, from shopping centers to all manner of different buildings and city transportation systems (Lucie-Smith, 1993). Houses have changed, vehicles have changed, and cellphones continue to change. Humans 10,000 years ago were the same human being. So, people are born with the same physical characteristics and they change and explore their capacity, talents, and intelligence with the nurturing comes from

family, school and community and make every individual to be expert or interested on certain areas of expertise. Therefore, schools are great places to explore children's potential for creating and designing the future. According to Martinez and Stager (2013) "Mario Montessori said the hands are the instruments of man's intelligence but intelligence is not only in the act of making, it is in extending ones own intelligence with interesting materials and tools (p. 33). So with the schools and classrooms equipped with resources and tools of STEAM model, students can develop existing resources and take them to the next level.

The second most beneficial feature of STEAM curriculum implementation is to help foster student achievement. Student morale and satisfaction in the school setting contribute to student success. Any student trying to memorize the parts of the nervous system and the function of the brain from only a text or diagram along with a lecture seems stressful. But if the classroom is set up to learn with a design model, the students' enthusiasm might make the subject easy to understand and make the knowledge permanent. Vecchi (2010) was inspired by Reggio Emilia, and in *Art and Creativity in Reggio Emilia: Exploring the Role and Potential of Ateliers in Early Childhood Education*, she makes an analogy between teaching and environmental elements, which is a great example for understanding the importance of the arts in STEAM curricula. Wootton (2008) believes that involvement with or implementation of the arts can provide joy, excitement, and happiness in learning. Developing a love for learning can have a profound effect on a student's education (Wootton, 2008). Music, painting, plays, and dancing are all instrumental in developing a child's passion for education (Bergonzi & Smith, 1996). According to the College Board, students with 4 years of art and music classes averaged 528 on the writing portion of the SAT test, which was 40 points higher than students with 5 years or less of art/music classes. Furthermore students who participate in the arts both in school and after

school demonstrate improved academic performance and lower dropout rates (Rabalais, 2014). The belief that an arts-embedded curriculum can improve academic achievement lies behind the idea that arts should be integrated into STEM, creating STEAM.

Erdogan and Stuessy (2005) studied the benefits of arts education and obtained impressive data that support the benefit of arts education on student achievement on the other subjects. Students from exclusive STEM schools performed slightly better on mathematics high-stakes tests, were 1.8 times more likely to meet benchmarks for reading and mathematics high-stakes tests, and were 0.8 times less likely to be absent from school. Furthermore, students attending inclusive STEM schools or traditional schools were questioned on their interest in STEM subjects and college matriculation, which showed that eighth-grade students attending inclusive STEM schools were more interested in STEM subjects than similar students attending traditional schools. In addition, students attending inclusive STEM schools exhibited more confidence about earning high school and college diplomas than students attending traditional schools. STEM schools have been shown to have profound effects on student achievement and self-confidence compared to traditional schools, because real world challenges are commonly interdisciplinary, and integrated approaches to teaching and learning can support deeper understanding of the complexities involved (Clark & Button, 2011; Petrie, 1992).

Another important benefit of STEAM education is identifying innovators when they are young and helping them become experts in their future careers. There are exemplary entrepreneurs who have become famous through having access to certain tools and environments when they were young. The similar characteristic of all of them is that they were exposed to modern and updated resources by their parents or community in their childhood (Wagner, 2012). For example, Marc Zuckerberg started Facebook when he was at college and became a legend.

Zuckerberg had a private tutor who was a college professor in the computer field. All innovators start their innovation process and interest between 5–16 years of age. If students cannot find any settings or resources, it might be difficult for them to come up with any innovation or study. Not everyone is fortunate enough to have parents who can provide every single setting and resources for their children. The STEAM school mindset might be a great asset for potential innovators who will be inventing new things. It would be better to have more Steve Jobs and Bill Gates in society to create different new innovations and alternative products and to allow people the opportunity to select different alternative products (Wagner, 2012).

There are many education programs and exemplary schools in the world, so every educational publishing resource or tool are being promoted and advertised in a way, they are effective for students to learn, for increasing reading scores, and for improving science and technology skills. Existing products or resources are difficult to implement at the school setting because of budgets or lack of trained staff. The literature reviewed for the present study support the idea that a STEAM school model is not a book or program to be implemented. Instead, it is a way to approach and educate students who will be connecting real life with the knowledge they get in school. It is not expensive to buy or implement; it is the idea that will be sufficient and effective in every century to help students become successful, enhance their creativity, and introduce the idea of becoming job innovators.

2.4 Common STEAM curricula implementation practices

STEAM curricula are not tangible and are not specifically explained. It can be helpful to understand the STEAM concept by making an analogy about cell DNA. DNA is the cell's code; without cell organelles, DNA cannot function and is useless. Likewise, schools, their components, and communities have similar functions to the cell organelles. The cohesion and

effective collaboration of all school components make implementing a STEAM curriculum functional, and getting school personnel to communicate well within the concept of STEAM implementation is vital. The STEM-focused high school environment serves as the setting for the microsystem. Perspectives of administrators, teachers, and students of the curricular and instructional practices and the general school culture allow for examining “the developing individual and the interrelationships between the individual and his or her contexts and also on the interconnections among the contexts themselves” (Hébert, 2011, p. 122).

Administration and staff vision, facility field trips, school-wide activities, cross-curricular activities, and competition all play major roles in contributing to STEAM curricula implementation (Cook, 2012). Members of school administration are some of the important players in establishing a STEAM curriculum. Establishing a STEAM curriculum is possible with the ongoing support of administrators. Teacher participation is also critical. Teacher collaboration on certain school projects and activities is essential. So too are updating the school’s learning tools and professional development for teachers.

Leadership is crucial for meeting STEAM curriculum needs and to establish classroom design that will encourage children to think, create, and solve problems in new and innovative ways, thus providing opportunities for students and teachers to think outside the box and to be creative and collaborative in their approach to learning (Cook, 2012). School design plays an important role in connecting these new creativities and capabilities by providing a student-centered learning environment that looks beyond the traditional classroom, including STEAM-based tools such as electronic devices, 3-D printers, laser cutters, and robotic devices. Dewey (1934) stated that the learning environment, the classroom setting, and hands-on learning tools

have positive effects on student learning and success because experience and environment are always central in the learning process.

School-wide programs and activities are great ways to get all members of the school community to strengthen and enrich the STEAM curriculum. The stakeholders and elements of the STEAM curriculum implementation process, STEAM capstone projects, robotics programs, a cross-curricular culture involving all subject teachers, and problem-based learning are great ways to get students to use all the STEAM subject standards. STEAM capstone projects allow students to explore and develop their skills in terms of building, presenting, exploring, and marketing their strategy. For example, building a bridge project will lead students to understand and practice all the STEAM-based subject standards when building the bridge. This activity might be developed by adding such activities as designing and engineering the bridge, adding multimedia skills, writing reports, and presenting the activity. All of these activities are related to one of the STEAM disciplines, and the bridge activity is the outcome of STEAM-based curriculum.

Parent and school community awareness is also important in implementing the STEAM concept, and special programs can be designed to introduce them to STEAM elements and themes (Cook, 2012). For example, STEAM family nights and field trips are great opportunities to get teachers, administrators, and parents to learn together outside of school hours. Going to an apple orchard or strawberry farm and collecting the fruit, bringing it to school, and making apple pies and strawberry jam to sell at the school is a great way to make STEAM fun even at the pre-K and lower grade levels.

2.5 Teacher professional development

Professional development is the development of teachers' experiences, skills, and abilities to improve the quality of teaching and learning for all members of the school community (DeMonte, 2013). The rapid change of educational curriculum, culture, resources, and tools make the professional development necessary for the school communities.

One of the purposes of teacher professional development programs is to group teachers into teams by subject matter and grade. Teachers have an equal opportunity at various work experience levels and can gain the tools needed to be more successful. Educators are being called on to continually increase their knowledge base and learn new instructional techniques, strategies, and methodologies (Corcoran, 1995). If teachers continually improve themselves and their classroom performance, students will directly benefit. They will have stronger academic growth because current teaching strategies are being employed and they can witness their teacher's model of continuous/on-going educational advancement (Darling-Hammond & Berry, 2006).

According to Sparks (2002), an effective teacher professional development program should provide training that is ongoing, reflective, and supports the construction of a professional learning community. Sparks remarked that teacher professional development should be tailored to teachers' specific needs and embedded in their daily lives. Further, Sparks argued that such teacher professional development programs should come with strong support from school administration. One-day teacher professional development program sessions are not effective because they offer broad topics on teaching that do not give teachers content specific training. In order to meet the requirement of continuous teacher preparation, the components of professional development should be organized and managed effectively. More growth and partnering

opportunities, time, and training must be given to teachers so they can understand new state and local standards, revise the curriculum, and create, master, and reflect on new teaching strategies (Corcoran, 1995). Grossnickle and Layne (1991) stated that the typical design and presentation of traditional staff development does not provide enough time, energy, and money to meet teachers' anticipated goals and expectations. These opportunities must be well coordinated and meet the teachers' needs.

Traditional staff development most often fails because the staff development experiences are not well supported. The school system has to create experiences that will encourage and motivate teachers to adapt. In addition, high-stakes testing has limited professional training options, and many of these offerings are either skills training or "how-to-teach-the-test" classes (Berry, Turchi, Johnson, Hare, & Owens, 2003). Training must give teachers a chance to gain instructional strategies so they can meet student needs.

2.6 Online teacher professional development

Developing online professional development is more than translating a face-to-face experience to an electronic version. All of the features of effective professional development such as focus on individual, incremental steps, enhancement of content, technological and pedagogical knowledge, and personal feedback are uniquely appropriate and should be integrated in the online learning environment (Guskey, 1991; Koehler & Mishra, 2005).

Online teacher professional development is popular because of the need for professional development that can fit teachers' busy schedules and that provides access and ongoing support to important resources not otherwise affordable or even available locally (Dede & Ketelhut, 2009). Online teacher professional development provides flexibility by allowing participants, irrespective of location, to manage educational pursuits with work and personal responsibilities

(Stanford-Bowers, 2008). In addition, online teacher professional development can be offered in various forms, enabling individuals to participate in a class via video conferencing with the goal of making the online experience as close as possible to an in-class experience to an online asynchronous course. This negates the need for all participants to be available at the same time and allows participants to self-pace and complete course requirements according to their individual schedules.

Since 2006, online teacher professional development has emerged as an alternative to traditional face-to-face professional development. The concept of employing distance education to break down learning barriers is not new to education; rather, it has been available since long before communications technologies were widespread, and therefore the definition of distance learning has evolved over many years (Keegan, 1996; Nipper, 1989). Vonderwell, Liang, and Alderman (2007) stated that distance education enables groups that are separated by time and space to engage in the active production of shared knowledge.

Online teacher professional development offers unique benefits for teachers' continuing education. Online teacher professional development researchers have noted the advantages of "anywhere, anytime" learning and the development of lifelong learners (Abdal-Haqq, 1996; Carter, 2004; Dede, 2008). Yanes, Lowry, Anozie, and Simard (2003) conducted a review of research related to online teacher professional development and concluded that it gives teachers the ability to select individualized professional development and to direct and manage their own learning. According to Appana (2006), the benefits of online learning include that all learners, even those in distant or disadvantaged locations, realize the exchange of quality information.

Online teacher professional development allows participants to be self-directed and to use self-discipline to embrace their own learning (Barr & Miller, 2013). Online learning transcends

time and space requirements and opens up new markets and opportunities for teachers and students to interact (Barr & Miller, 2013).

Since online learning has been gaining popularity in school and business settings, online courses should involve more than just material presentation and delivery. The challenge for teachers and course developers working in an online learning context, therefore, is to construct a learning environment that is simultaneously learner-centered, content-centered, community-centered, and assessment-centered (Anderson, 2008). There is no single best medium for online learning, nor is there a formulaic specification that dictates the type of interaction most conducive to learning in all domains and with all learners. Rather, teachers must learn to develop their skills so that they can respond to existing and emergent student and curriculum needs. Anderson (2008) also stated that teachers can do this by developing a repertoire of online learning activities that are adaptable to diverse contextual and student needs.

2.7 Blended learning

Blended learning is an assimilation of theoretical and clinical skills learned in the classroom and online. The blended learning process encourages higher-order thinking in students (Hsu & Hsieh, 2014). Students learn through the transfer of content and instruction via online learning, collaborative working between themselves and academic staff, and through having some control over the time and place of work.

School districts and other educational institutions have developed blended professional development and course studies to get participants involved in these programs, which take longer and focus on very substantive study. The increasing demand and availability of doctorate, master's, and bachelor's degrees drove institutions to add some face-to-face sessions to motivate and help individuals graduate on time. As a result, blended courses help students who are not

self-directed or motivated not feel alone and isolated from their instructors and classmates (Barr & Miller, 2013; Borup, West, & Graham, 2012). Sometimes blended learning may isolate the problems arising from instructors' online portals, as instructors often struggle to personalize the classroom and provide supportive components for those who might be experiencing difficulty in class (deNoyelles, Zydney, & Chen, 2014). Garrison and Vaughn (2007) explored blended learning in a faculty development context and suggested that such an approach "may create a flexible and accessible environment for faculty to engage in sustained critical reflection and discourse about their teaching practice" (p. 150). Hui, Hu, Clark, Tam, and Milton (2007) demonstrated that technology-based learning improves student knowledge gaining, which requires abstract conceptualization and reflective observation, but adversely affects student ability to obtain knowledge, requiring concrete experience that is provided by the blended learning.

Blended education requires combining an effective learning experience with the instructor's skills and resources as well as with organizational meetings and lectures. These two components should be given the same knowledge and information. A face-to-face session should be established to make the online portion clear and effective.

2.8 The need for online STEAM professional development

Increasing numbers of new technological tools and new online curriculum resources in 21st-century schools have created pressure on school stakeholders, including parents, students, teachers, school boards, and administrators (Nadelson, Seifert, & Hendricks, 2015). The changes also create many problems for administrators and board members when planning new programs that include Next Generation Science Standards, Common Core mathematics, and online textbooks. STEAM professional development can benefit teachers and administrators as well.

For example, imagine a school in which three different groups of people of various ages are trying to understand each other while they are spending more than 50% of their time in the same building. All the different groups have different perceptions of education because of their age differences, and each group thinks and solves problems differently because of the tools they use. Imagine that a school principal around 45–65 years of age is thinking differently than teachers who are between 23–35 years old. This age difference separates them because of when they were in school; the principal learned everything in a classic way on the blackboard, the teachers learned via overhead projectors and smart boards. Consider elementary and middle school students who are learning from teachers who are teaching the subjects according to their frame of reference in time. These students may feel very frustrated with their teachers' teaching methods.

Because their ages differ, all of these people have difficulty understanding each other. The principal's agenda is to get good test scores, the teachers' agenda is to get students to understand the subject quickly, and the student agenda is more related to finishing the day and going home. All of these factors can demotivate teachers who are working hard to fulfill all the requirements of STEAM education implementation and can affect teacher retention rates. Among the estimated 426,000 middle and high school STEM teachers in the United States, about 25,000 of them leave their teaching profession every year (Ingersoll & Perda, 2010).

The issues are not only due to the quantity of STEM teachers and administrators. The quality of teacher education programs is also a crucial issue. Many pre- and in-service teacher education programs provide insufficient technology skills preparation. As a result, many newly graduated teachers are not prepared to use computers in the teaching-learning processes (Kurz & Middleton, 2006). Similarly, a 2006 National Center on Education and the Economy report stated that teachers who educate elementary- to high-school level students get their information

and attitudes about STEM disciplines from college- and university-level teacher education courses. However, technology has not reached its potential in teacher education curricula nationwide.

Many newly graduated teachers often do not have adequate experience in using computers in teaching-learning processes (Kurz & Middleton, 2006). According to Hossain and Robinson (2012), many technology preparation classes only adequately prepare preservice teachers with lower-level technology skills and do not equip them for providing sufficient technology-based instruction in their classrooms.

Sikma and Osborne (2014) researched teacher professional development for STEM curriculum implementation in Frederick Douglass Elementary, a K-5 school in a small midwestern town. They interviewed teachers regarding their beliefs about for the new STEM curriculum. Results showed that teachers were glad to have STEM professional development, but they could not determine the ultimate goal of delivered STEM professional development. The teachers also stated that they felt uncomfortable with STEM subject areas, particularly at the elementary school level. This created additional stress for these teachers, who had a great deal of difficulty understanding how engineering, for example, can fit into a fifth-grade unit on plants let alone in a kindergarten classroom (Sikma & Osborne, 2014).

Sikma and Osborne's (2014) research supports the idea that learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own actions to inform them what to do. As such, expecting teachers to accept and collaborate to teach STEM or STEAM subjects at the elementary level depends on human behavior that is learned observationally through modeling from observing others (Bandura, 1977) in the education world.

In considering the increasing number of educational tools, resources, and new standards, teacher training is an important need in schools. Teacher adoption of new initiatives such as Next Generation Science Standards and Common Core standards for mathematics has been difficult because of teachers' lack of experience and autonomy. Nadelson et al. (2015) also stated that many teachers hold perceptions and conceptions of Common Core mathematics standards that may be ineffective or useless. Some teachers' desires to maintain similar methods of teaching and learning, and their being so conservative, are likely to prevent efforts to embrace core STEM practices and consider new instructional approaches and curriculum choices. As such, shifting teachers' perceptions and instructional practices likely requires professional development that supports adoption and implementation of innovations such as teaching in ways that engage students in core STEM practices. Excellent professional development may enable and expose teachers to the practices and engage them in activities so that they may experience situations that illuminate ideas for and the benefits of teaching to the practice.

School-wide professional development can bring teachers together to collaborate and create unique school-wide projects for each grade. These school-wide projects allow students to apply all the knowledge belonging to each discipline. While students follow daily lesson activities, they will aim to use all this information to complete projects. These projects vary from writing phone applications to building robots, making artwork, or writing essays to be published. It is very important to include the school principal in this process because the school principal is vital to implementing any project at the school.

Teacher collaboration is very important. Science, the arts, language arts, and social studies teachers should be getting together and giving feedback to each other while they are observing the progress of the capstone projects, for example. Any well-designed STEAM

professional development software or online program that includes the best practices of STEAM-based school-wide activities, cross-curricular activities, media clubs, special projects, expos, and participating models helps everybody start thinking in the same way to make a change from classical teaching to STEAM-designed teaching (Yakman, 2008). As educators, having access to STEAM-blended resources and STEAM professional development is crucial in order to educate members of the current generation, get them ready for the future, and allow them carry all the existing technology and inventions to the next level.

The U.S. Department of Commerce estimates that STEM-related jobs will grow 17%, nearly double the growth for non-STEM fields. By 2018, the United States will have more than 1,200,000 unfilled STEM jobs because there will not be enough qualified workers to fill them (Dugger, 2010). Students should be well educated by highly qualified teachers who can teach all STEAM subjects in order to fulfill all jobs to meet all the needs of expectations in the future. The teacher's role is critical in educating these students.

Chapter 3. Research Methodology

3.1 Research design

This study's purpose was to investigate the impact of a 1-week online STEAM professional development course on teacher behavior and their perceptions of their self-efficacy regarding integrating STEAM concepts in their classroom instruction, lesson plans, and extracurricular activities. The study setting was a private school (preschool through Grade 8) with a focus on science and math education in a large Midwestern city.

The study was quantitative and was based on a quasi-experimental survey design using a pretest and posttest administered via Survey Monkey, an online survey development cloud-based software. Conducting a quantitative study resulted in acquiring the numerical data necessary to determine the effect of the independent variable of a 1-week STEAM online professional development course on the dependent variable of change in teacher behavior, perceptions, and STEAM teaching efficacy, which were measured using pre- and posttest survey scores (Creswell, 2009; Leedy & Ormrod, 2010). Because of the present study's specific focus, a quantitative approach provided the means to obtain accurate data yielding precise measurements of the variables necessary to confirm or disprove the hypotheses.

A quasi-experimental design was selected for this study because of the necessity for data that determined the relationship between the independent variable and dependent variable and the research objective of proving or disproving the relationship between the effectiveness of 1 week of STEAM online professional development course on teacher's behavior, perceptions, and STEAM teaching efficacy. The study population was a nonequivalent group and is defined as an experiment where existing groups are not divided so there was a single group, which best supported a quasi-experimental design. Using preassessment measurements provided baseline

data for the dependent variable, and postassessment measurements provided data reflecting the independent variable.

The focus of this study entailed testing specific hypotheses by applying statistical tests to data collected from the surveys. The Wilcoxon signed-rank test was used to analyze the survey data collected for hypothesis testing (Wilcoxon, 1945). This test is widely regarded to be the most appropriate test for paired-sample data in making inferences concerning the value of the median of the population of differences. *T* tests were also used to check the robustness of the results obtained using the Wilcoxon signed-rank test (Ahad, Yahaya, MdYusof, Abdullah, & Fung, 2014). The *t* test approach tests the statistical significance of the difference between the means of pre- and posttest responses to each survey question. Table 1 details the present study's research questions, alternative hypothesis, and the methods of analysis used.

Table 1

Research Questions, Alternative Hypotheses, and Methods of Analyses

Research question	Alternative hypothesis	Type of statistical analyses	Specific procedures used
Research Question 1: To what extent would a 1-week STEAM online professional development course affect preschool through Grade 8 teachers' behaviors and perceptions regarding their self-efficacy for implementing STEAM-based activities in their classrooms and encourage teachers to be open to using new innovations in the education setting?	A 1-week STEAM online professional development course for preschool through Grade 8 teachers will have a significant affect on teachers' behaviors and perceptions regarding their self-efficacy for implementing STEAM-based activities in their classroom and will encourage teachers to be open to using new innovations in the education setting.	Descriptive inferential	Means, <i>t</i> test, Wilcoxon signed-rank test
Research Question 2: To what extent is a 1-week STEAM online professional development course an effective tool for helping educators understand STEAM's general meaning and implementation in the schools?	A 1-week STEAM online professional development course is an effective tool for helping educators understand STEAM's general meaning and implementation in the schools.	Descriptive inferential	Means, <i>t</i> test, Wilcoxon signed-rank test

3.2 Description of participants

The study sample was teachers employed at a private school (preschool through Grade 8) with a focus on science and math education in a large midwestern city. A total of 33 teachers are employed at this school, and approximately 30 teachers were expected to participate in this study. The sample size was determined according to teachers' voluntary participation. The final sample was $N = 26$. In terms of teachers' experience about STEM or STEAM professional development, seven (28%) teachers participated in STEM–STEAM-based professional

development and 16 (61.54%) teachers experienced online professional development in their career.

3.3 Measures

I developed a 16-question survey (see Appendix A). Four questions related to the participants' background information, such as grade taught, and their previous professional development activities. The remaining 12 questions were designed to gather information about the impact of the STEAM-based online professional development on teachers' perceptions of their STEAM teaching efficacy and beliefs about STEAM.

To answer the 12 questions on the impact of the STEAM professional development, teachers were asked to indicate the response that best reflected their beliefs. These responses were (a) Strongly agree, (b) Agree, (c) Neither agree nor disagree, (d) Disagree, and (e) Strongly disagree. For analysis purposes, these responses were converted to a 5-point Likert-type scale, with (a) *Strongly agree* corresponding to 5 on the scale and (e) *Strongly disagree* corresponding to 1 on the scale (Creswell, 2003). *Scoring data* means that the researcher assigns a numeric score (or value) to each response category for each question on the instruments used to collect data.

3.4 Procedures

I developed a 1-week online STEAM-based professional development course for the present study to see if STEAM-based online professional development is effective and would change the teachers' perceptions of their self-efficacy and behavior regarding STEAM curricula. Teachers were surveyed in order to collect data about the change of self-efficacy and behavior factors prior to and after taking the 1-week online course.

The course included four modules. The first module included video and a lecture about the definition of STEAM curricula and how it evolved from STEM. The second module included a video and lecture about the main reasons and benefit of implementing STEAM curricula in the schools. The third module included some demonstrations and videos based on some STEAM curriculum lesson projects and ideas. The fourth module was about implementing STEAM-based education in other countries and practices. The course included discussion board questions for each module for participants to respond to. During the research time period, I posted discussion board questions for each module to make sure the participants studied the course materials. Participants were provided a username and password for accessing the online course.

An email including an informational letter that described the research study was sent to potential participants (see Appendix B). The email also contained a letter of informed consent (see Appendix C). Participants were invited to participate in a study to answer 12 questions about such topics as the definition of STEAM curriculum, general practices of STEAM curricula, the global popularity of STEAM curriculum, and the future of STEAM curriculum for the purpose of the pretest, and the same test was given as a posttest after the 1-week online STEAM professional development course. “A pretest provides a measure on some attribute or characteristic that you assess for participants in an experiment *before* they receive a treatment. After the treatment, you take another reading on the attribute or characteristic. A posttest is a measure on some attribute or characteristic that is assessed for participants in an experiment *after* a treatment” (Creswell, 2008, p. 297).

After receiving approval letters from participants, I posted a link to the pretest survey on SurveyMonkey and gave participants a deadline for completing the survey. Participants were

given pseudonyms for privacy. Participants who completed the pretest survey were then sent a link to the online course, which was presented using Course Sites by Blackboard, is a free, hosted online course creation and facilitation service that empowers individual K–12 teachers, college and university instructors and community educators to add a web–based component to their courses, or even host an entire course on the Internet. I sent several emails with instructions for using Blackboard and to remind participants to complete the modules and respond to the discussion board questions. Participants were sent a link to the posttest survey after they completed the online course by responding to each module’s discussion board question. Discussion board questions were aligned with the 12 survey questions. I checked all pretest and posttest responses of participants and sent confirmations to participants when the study was completed.

Data were downloaded from SurveyMonkey.com into Excel for coding and then uploaded into STATA for analysis since STATA’s capabilities include data management, statistical analysis, graphics, simulations, regression, and custom programming. Reliability analysis was conducted to verify whether or not any questions were reverse coded. Means analysis, frequencies, and appropriate statistical tests such as *t* tests were conducted to compare the variables (Creswell, 2003).

3.5 Data analysis

All data were transferred from SurveyMonkey.com to STATA by coding the survey results. I used a Likert-type scale to score the questions as this scale enables collecting quantitative data in order to test hypotheses. There were two different tests applied to the data in order to provide support (or lack thereof) for study hypotheses. The Wilcoxon signed-rank test is widely used in univariate statistical analysis of paired survey data to test for the median

difference in two groups. The groups in the present study are represented by the pre- and posttest survey answers paired for the same survey participants. Since the Wilcoxon signed-rank test is nonparametric, it does not require population data to follow a particular probability distribution to be valid for statistical inference in a survey study. Nevertheless, the paired t test approach was also used to check the robustness of the Wilcoxon signed-rank test results. The paired t test tests the statistical significant of the average pre- and posttest survey answers under the assumption that the population data for the responses to each question follows a normal distribution. In both the Wilcoxon signed-rank test and the t test a one-sided p value of less than 0.05 is considered statistically significant. The statistical software package STATA 11 for Windows was used for all statistical analyses.

Chapter 4. Results

4.1 Descriptive and inferential data

Twenty-nine teachers responded to the pretest survey; however, three teachers did not respond to the posttest survey on time. Therefore, the final sample was $N = 26$. Instructional levels and numbers of teachers at each are as follows:

- Preschool: eight (30.77%).
- Kindergarten: two (7.69%).
- Elementary school: 12 (46.15%).
- Middle school: 14 (53.85%).

Data regarding teachers' STEAM-based professional experiences are as follows:

- Thirteen (50%) participated in educational technology professional development.
- Eleven (44%) teachers participated in 21st-century teaching method professional development.
- Seven (28%) teachers participated globalization in education professional development.
- Eleven (44%) teachers participated computer skills professional development.
- Seven (28%) teachers participated to STEM-STEAM based professional development.
- Sixteen (61.54%) teachers experienced online professional development in their career.

The demographic questions (1 through 4) on the survey were only administered once. The remaining 12 questions were the pretest and posttest questions designed to gather data for study analysis. These 12 questions were renumbered 1–12 for the purpose of the following discussion.

The data extracted from STATA were analyzed through a Wilcoxon signed-rank test and t test approach to find out the impact of STEAM-based professional development on teachers'

perceptions of their beliefs and self-efficacy regarding implementing STEAM-based curricula. Each question's pretreatment and posttreatment data were evaluated by the Wilcoxon signed-rank test for paired samples. The Wilcoxon signed-rank test was actually proposed for paired-sample data in making inferences concerning the value of the median of the population of differences. Given a random sample of n pairs of observations $(X_1, Y_1), (X_2, Y_2) \dots (X_n, Y_n)$, it is assumed that their differences (i.e., $X_1 - Y_1, X_2 - Y_2 \dots X_n - Y_n$) are independent observations from a population of differences, which is continuous and symmetric with median M_0 . Suppose there is a random sample of n pairs of observations $(x_1, y_1), (x_2, y_2) \dots (x_n, y_n)$. In order to test the hypothesis $H_0: MD = M_0$, the n differences $d_i = x_i - y_i - M_0$ could be used. These procedures for a one-sample case are equally applicable here with the same notation, except that the parameter MD must be interpreted now as the median of the population of differences. And the test approach to test the difference in the post- and pre-test mean responses if there is any significant difference with a t statistics corresponding to t statistics corresponding to p value (Taheri & Hesamian, 2013). Table 2 shows t test results. Table 3 shows the Wilcoxon test comparison.

Table 2

T Test of the Difference Between Pre- and Posttreatment Survey Responses

Question	Responses and measures				
	Posttest average response (1-5 scale)	Pretest average response (1-5 scale)	Difference in average response	<i>t</i> statistic	One-sided <i>t</i> test H_a : Posttest > pretest <i>p</i> value
1. A school-wide science, technology, engineering, arts, and math (STEAM) online professional development course is effective for teachers.	4.57692	4.11539	0.46154	2.2875	0.0154
2. A school-wide science, technology, engineering, arts, and math (STEAM) online professional development course gives me great insight into my classroom setting.	4.34615	3.84615	0.18605	2.6874	0.0063
3. I could benefit from online STEAM professional development in order to be aware of current resources, publications, and tools related to 21st-century learning styles in the school setting.	4.769231	3.846154	0.923077	5.5709	0
4. A school-wide online STEAM professional development course will help me clearly understand the school's mission and vision.	4.692308	3.730769	0.961539	5.9524	0
5. Attending an online STEAM professional development course will be more convenient than participating in face-to-face professional development.	3.846154	3.192308	0.653846	3.7383	0.0005

(continued)

Table 2

T Test of the Difference Between Pre- and Posttreatment Survey Responses (continued)

Question	Responses and measures				
	Posttest average response (1-5 scale)	Pretest average response (1-5 scale)	Difference in average response	<i>t</i> statistic	One-sided <i>t</i> test H_a : Posttest > pretest <i>p</i> value
6. I could learn some skills to collaborate with other teachers effectively through school-wide online STEAM professional development.	4.44	3.8	0.64	2.6215	0.0075
7. I could get more ideas to help organize STEAM-based activities at my school through participating in a school-wide online STEAM professional development course.	4.5	3.923077	0.576923	3.1115	0.0023
8. Participating in a school-wide online STEAM professional development course may advance my teaching skills and effectiveness based on 21st-century teaching standards.	4.5	3.884615	0.615385	3.3333	0.0013
9. I could learn more about global competition through STEAM-based education practices by participating in an online STEAM professional development course.	4.615385	3.807692	0.807692	4.6001	0.0001
10. I could learn about best practices implemented globally regarding STEAM-based curriculum through participating in an online STEAM professional development course.	4.538462	3.653846	0.884615	4.5422	0.0001
11. I would like to learn about STEAM-based curriculum through school-wide online STEAM professional development	4.346154	3.807692	0.538462	2.6687	0.0066

(continued)

Table 2

T Test of the Difference Between Pre- and Posttreatment Survey Responses (continued)

Question	Responses and measures				
	Posttest average response (1-5 scale)	Pretest average response (1-5 scale)	Difference in average response	<i>t</i> statistic	One-sided <i>t</i> test H_a : Posttest > pretest <i>p</i> value
12. I would prefer online STEAM professional development to face-to-face STEAM professional development.	3.769231	3.076923	0.692308	2.8808	0.004

Table 3

Wilcoxon Signed-Rank Test of the Difference Between Pre- and Posttreatment Survey Responses
(N = 26)

Question	Posttest response > pretest response	Posttest response = pretest response	Posttest response < pretest response	One-sided Wilcoxon signed-ranks test H_a : Posttest > pretest p value
1. A school-wide science, technology, engineering, arts, and math (STEAM) online professional development course is effective for teachers.	13	11	2	0.0037
2. A school-wide science, technology, engineering, arts, and math (STEAM) online professional development course gives me great insight into my classroom setting.	14	9	3	0.0064
3. I could benefit from online STEAM professional development in order to be aware of current resources, publications, and tools related to 21st-century learning styles in the school setting.	18	7	1	0.0001
4. A school-wide online STEAM professional development course will help me clearly understand the school's mission and vision.	18	8	0	0.0001
5. Attending an online STEAM professional development course will be more convenient than participating in face-to-face professional development.	16	7	3	0.0022
6. I could learn some skills to collaborate with other teachers effectively through school-wide online STEAM professional development.	16	5	4	0.0059
7. I could get more ideas to help organize STEAM-based activities at my school through participating in a school-wide online STEAM professional development course.	15	7	4	0.0096

(continued)

Table 3

Wilcoxon Signed-Rank Test of the Difference Between Pre- and Posttreatment Survey Responses (N = 26) (continued)

Question	Posttest response > pretest response	Posttest response = pretest response	Posttest response < pretest response	One-sided Wilcoxon signed-ranks test H_a : Posttest > pretest p value
8. Participating in a school-wide online STEAM professional development course may advance my teaching skills and effectiveness based on 21st-century teaching standards.	16	6	4	0.0059
9. I could learn more about global competition through STEAM-based education practices by participating in an online STEAM professional development course.	16	10	0	0.0001
10. I could learn about best practices implemented globally regarding STEAM-based curriculum through participating in an online STEAM professional development course.	18	7	1	0.0001
11. I would like to learn about STEAM-based curriculum through school-wide online STEAM professional development.	15	7	4	0.0096
12. I would prefer online STEAM professional development to face-to-face STEAM professional development.	15	9	2	0.0012

Question 1 asked whether a school-wide STEAM online professional development course is effective for teachers. To test for the change in the responses to this question from pretest to posttest, I used the Wilcoxon signed-rank test. For Question 1, the median posttest response was statistically significantly greater than the median pretest response with a p value of less than 0.01. Based on this analysis, the STEAM-based online professional development course had a positive impact on teachers' perceptions of STEAM-based professional development.

For Question 1, the mean response was 4.57 for posttest and 4.11 for pretest with a difference of 0.46. Using the *t* test approach, this difference is statistically significant with a *t* statistics of 2.287 corresponding to a *p* value of 0.015. This result confirms that posttest perception of STEAM training on teachers is significantly greater than their pretest perception.

Question 2 regarded the effect of STEAM professional development on teachers' insights on their classroom setting. In testing for the change in the responses from pretest to posttest, I found that the median posttest response was statistically significantly greater than the median pretest response with a *p* value of less than 0.01. Based on these results, the STEAM-based online professional development had a positive impact on teacher's insights on their classroom setting.

For Question 2, the mean response was 4.35 for posttest and 3.84 for pretest with a difference of 0.18. This difference is statistically significant with a *t* statistic of 2.6874 corresponding to a *p* value of 0.0063. This result confirms that the impact of STEAM-based professional development on teachers' classroom setting was significantly greater than their pretest perception.

Question 3 regarded teachers' beliefs of the benefits of STEAM professional development regarding awareness of current resources, publications, and tools related to the learning styles of 21st-century learners in the school setting. Using the Wilcoxon signed-rank test, the results show that the median posttest response was statistically significantly greater than the median pretest response with a *p* value of less than 0.01. Based on these results, the STEAM-based online professional development had a positive impact on teachers' awareness of current resources, publications, and tools related to the learning styles of 21st-century learners in the school setting.

For Question 3, the mean response was 4.77 for posttest and 3.85 for pretest with a difference of 0.92. This difference is statistically significant with a t statistic of 5.57 corresponding to a p value of less than 0.01. This result confirms that teachers' posttest perceptions were significantly greater than their pretest perceptions.

Question 4 regarded the impact of the STEAM-based online professional development on teachers' understanding of the school's mission and vision. Using the Wilcoxon signed-rank test, the median posttest response was statistically significantly greater than the median pretest response with a p value of less than 0.01. This shows that the STEAM-based online professional development had a positive impact on teachers' understanding of school mission and vision.

For Question 4, the mean response was 4.69 for posttest and is 3.73 for pretest with a difference of 0.96. This difference is statistically significant with a t statistic of 5.95 corresponding to a p value of 0. This result confirms that posttest response regarding teachers' understanding of school mission and vision was significantly greater than their pretest understanding of school mission and vision.

Question 5 regarded teachers' perceptions of the convenience of attending an online STEAM professional development course compared to participating in a face-to-face course. To test for the change in the responses to this question from pretest to posttest I used the Wilcoxon signed-rank test. The median posttest response was statistically significantly greater than the median pretest response with a p value of less than 0.01, showing that teachers found the STEAM-based online professional development more convenient.

For Question 5, the mean response was 3.85 for posttest and 3.2 for pretest with a difference of 0.65. This difference is statistically significant with a t statistic of 3.74 corresponding to a p value of 0.0005. This result confirms teachers' posttest belief that an online

STEAM professional development course is more convenient than participating in a face-to-face course.

Question 6 regarded teachers' beliefs regarding learning some skills for effective collaboration with other teachers through school-wide online STEAM professional development. Using the Wilcoxon signed-rank test, the median posttest response was statistically significantly greater than the median pretest response with a p value of less than 0.01, indicating that online STEAM professional development had a positive impact on teachers' beliefs regarding learning some skills for effective collaboration.

For Question 6, the mean response was 4.44 for posttest and 3.8 for pretest with a difference of 0.64. This difference is statistically significant with a t statistic of 2.6215 corresponding to a p value of 0.0075. This result confirms that posttest teacher beliefs regarding learning collaboration skills are significantly greater than their pretest beliefs.

The seventh question regarded teachers' beliefs on obtaining more ideas for organizing STEAM-based activities at their school through participating in online STEAM professional development. Using the Wilcoxon signed-rank test, the median posttest response was statistically significantly greater than the median pretest response with a p value of less than 0.01, indicating that online STEAM professional development positively impacted teachers' beliefs regarding obtaining more ideas for organizing STEAM-based activities at their school through participating in online STEAM professional development.

For Question 7, the mean response was 4.5 for posttest and 3.9 for pretest with a difference of 0.57. This difference is statistically significant with a t statistic of 3.1 corresponding to a p value of 0.0023. This result confirms that posttest beliefs regarding obtaining more ideas for organizing STEAM-based activities at their school through

participating in online STEAM professional development are significantly greater than their pretest beliefs.

Question 8 concerned teachers' beliefs on whether participating in school-wide online STEAM professional development would advance their teaching skills and effectiveness based on 21st-century teaching standards. Using the Wilcoxon signed-rank test, the median posttest response was statistically significantly greater than the median pretest response with a p value of less than 0.01, indicating that the online STEAM professional development course positively impacted teachers' beliefs about advancing their teaching skills and effectiveness based on 21st-century teaching standards.

For Question 8, the mean response was 4.5 for posttest and 3.9 for pretest with a difference of 0.61. This difference is statistically significant with a t statistic of 3.33 corresponding to a p value of 0.013. This result confirms that teachers' posttest perceptions of their teaching skills and effectiveness based on 21st-century teaching standards are significantly greater than their pretest perceptions.

Question 9 probed teachers' beliefs regarding learning more about global competition through online STEAM-based professional development. Using the Wilcoxon signed-rank test, the median posttest response was statistically significantly greater than the median pretest response with a p value of less than 0.01. This indicated that online STEAM professional development positively impacted teachers' beliefs regarding learning more about global competition.

For Question 9, the mean response was 4.61 for posttest and 3.81 for pretest with a difference of 0.81. This difference is statistically significant with a t statistic of 4.60

corresponding to a p value of 0.001, confirming that that posttest beliefs regarding learning more about global competition are significantly greater than pretest beliefs.

Question 10 concerned teachers' beliefs regarding learning about best practices implemented globally regarding STEAM-based curriculum through participating in online STEAM professional development. Using the Wilcoxon signed-rank test, the median posttest response was statistically significantly greater than the median pretest response with a p value of less than 0.01, indicating that online STEAM professional development positively impacted teachers' beliefs regarding learning about best practices implemented globally.

For Question 10, the mean response was 4.53 for posttest and 3.65 for pretest with a difference of 0.89. This difference is statistically significant with a t statistic of 4.54 corresponding to a p value of 0.001. This result confirms that teachers' posttest beliefs regarding learning about best practices implemented globally regarding STEAM-based curriculum are significantly greater than their pretest beliefs.

Question 11 regarded teachers' beliefs on learning about STEAM-based curriculum through school-wide online STEAM professional development. Using the Wilcoxon signed-rank test, the median posttest response was statistically significantly greater than the median pretest response with a p value of less than 0.01, indicating that online STEAM professional development positively impacted teachers' beliefs on learning about STEAM-based curriculum through school-wide online STEAM professional development.

For Question 11, the mean response was 4.36 for posttest and 3.81 for pretest with a difference of 0.54. This difference is statistically significant with a t statistic of 2.67 corresponding to a p value of 0.001. This result confirms that teachers' posttest beliefs on

learning about STEAM-based curriculum through school-wide online STEAM professional development are significantly greater than their pretest beliefs.

Question 12 asked whether teachers preferred online STEAM professional development to face-to-face professional development. Using the Wilcoxon signed-rank test, the median posttest response was statistically significantly greater than the median pretest response with a p value of less than 0.01, indicating that teachers preferred online STEAM professional development to face-to-face professional development.

For Question 12, the mean response was 3.77 for posttest and 3.07 for pretest with a difference of 0.69. This difference is statistically significant with a t statistic of 2.88 corresponding to a p value of 0.004. This result confirms that teachers preferred online STEAM professional development to face-to-face professional development.

4.2 Brief review of findings

RQ1 was: To what extent would a 1-week STEAM online professional development course affect preschool through Grade 8 teachers' behaviors and perceptions regarding their self-efficacy for implementing STEAM-based activities in their classrooms and encourage teachers to be open to using new innovations in the education setting? Null Hypothesis 1 ($H1_0$): A 1-week STEAM online professional development course for preschool through Grade 8 teachers will not significantly affect teachers' behaviors and perceptions regarding their self-efficacy for implementing STEAM-based activities in their classrooms and will not encourage teachers to be open to using new innovations in the education setting. Alternative Hypothesis 1 ($H1_a$): A 1-week STEAM online professional development course for preschool through Grade 8 teachers will have a significant affect on teachers' behaviors and perceptions regarding their self-efficacy

for implementing STEAM-based activities in their classroom and will encourage teachers to be open to using new innovations in the education setting.

Survey Questions 1, 5, and 12 were designed to test the first hypothesis. Based on analysis results, the alternative hypothesis for RQ1 was accepted as all p values for the responses on the survey questions were less than 0.05.

RQ2 was: To what extent is a 1-week STEAM online professional development course an effective tool for helping educators understand STEAM's general meaning and implementation in the schools? Null Hypothesis 2 ($H2_0$): A 1-week STEAM online professional development course is not an effective tool for helping educators understand STEAM's general meaning and implementation in the schools. Alternative Hypothesis 2 ($H2_a$): A 1-week STEAM online professional development course is an effective tool for helping educators understand STEAM's general meaning and implementation in the schools.

Survey Questions 2, 3, 4, 6, 7, 8, 9,10 and 11 were designed to test the second hypothesis. Based on analysis results, STEAM-based online professional development is effective for teachers and other educators. As such, the alternative hypothesis for RQ2 was accepted since all p values for the responses on the survey questions were less than 0.05.

Chapter 5. Discussion

The online STEAM professional development, including different videos and demonstrations related to the themes of investigating the best food options, changes in world trade centers throughout history based on scientific development, making business plans, and making a simple robot, was aimed to inspire teachers and educators to come up with other authentic ideas and lesson plans in terms of implementing an STEAM curricula and to help spread the STEAM concept in education and business settings. So, mentioning other ideas would be perfect in addition to the online STEAM professional development.

Cross-curricular activities and problem-based education are the general activities for establishing STEAM curriculum. They are great ice-breaking times for teachers and foster imaginative ways to get children to use all of their senses in learning to remember and to process what they learn and to engage in problem-solving. The robotics and technology programs are considered great STEAM tools for meeting the cross-curricular activity concept, a multiple-subject system that teaches children everything from science, technology, engineering, and math to problem-solving and self-assessment. Using their imagination, students are easily able to program the robot.

Robotic competitions, science fairs, math competitions, and club activities are great ways to implement STEAM curriculum at the schools. These activities also incorporate project-based learning, cross-curricular teaching, and problem-based learning. For robotic competitions, students can use everything they have learned from studying STEAM subjects to be successful. These activities not only get students to learn the STEAM subjects, they also help students practice being competitive. These competitions reward students based on different criteria, including the best-designed robot, the winning robot, the most challenging robot, the best

marketing team, the best video, and so on. Teams of students design all the robots, which compete by accomplishing the designated mission for each competition every year. It is not enough to just get the robot working, it is also important for students to convince the judges and present and exhibit teamwork. Getting students to this level requires schools to establish good curriculum design and then educate students to be problem-solvers and to use all that they learn from the STEAM subjects to make the robot or other devices from scratch, make it work, fix it, etc. Building a robot is just one example of STEAM implementation. Any student who wants to build a robot should have good knowledge of physics theories including motion, force, power, and gravity. These students should also have access to coding and technology, engineering, and art related to the design section of the model. Papert (1980) also emphasized the importance of computer education by agreeing that children program computers, and in doing so acquire a sense of mastery over a piece of the most modern and powerful technology and establish an intimate contact with some of the deepest ideas from science, from mathematics, and from the art of intellectual model building.

Robotics competitions engage participants in fixed and open-ended activities, and as suggested by Martin, one of the inventors of the LEGO robotics platform, open-ended exhibitions might promote more creativity than fixed-game competitions. Robotics programs also contribute to children being successful in science and math. On the other hand, media clubs including newspaper and television also are great ways to incorporate STEAM knowledge into curriculum. Creating a newspaper or producing a television program includes several STEAM-related activities and skills. Using a camera, taping the event, using some computer programs, using social studies and language arts in establishing the theme can all help students to practice

what they have learned and reflect on what they have produced. Clubs like these also create social connections between students, the community, parents, and staff.

Having a schoolwide online STEAM professional development initiated by the school administration can foster great change in the education world, not only in the U.S. education system but in other countries as well. An immediate change would be less need for funding traditional professional development experiences. In leading teachers through effective STEAM based-lesson plans and providing outreach to schools serving disadvantaged students through implementing online STEAM-based professional development in the schools, teachers and students can take advantage of new trends in education. The anticipated result would be to encourage policy changes at the college level and in the business setting through adding a different flavor to the teachers' professional development sector.

Schools, school districts, and teachers spend a great amount of money for different professional development programs. These professional development activities and their outcomes are not generally monitored and assessed by administrators and department chairs. It is often assumed that teacher professional development is merely a means of educating the teacher at a personal level without consideration of the potential impact on the school and school culture. Ideally, schools should provide these professional development opportunities every year; online professional development that involves the school administration would be the most effective approach as it is accessible for teachers and administration anytime, anywhere within an affordable budget. Furthermore, having access to STEAM-based professional development in the school setting would foster collaboration among all elementary and middle school arts, science, math, and computer teachers. It would allow teachers to exchange knowledge and skills in order to create effective hands-on lesson plans. This collaboration, through an effective online

professional development format, would help close information and knowledge gaps among elementary school teachers and help them set up scientific experiments, get students to learn different computer programs, and help them assist students in creating meaningful art projects. Thus, an online professional development initiative, organized and planned by school or district administration, with the inclusion of assessments and updates every year would allow the school to be more effective and functional. In addition, it would introduce teachers to new and innovative resources in a timely and effective way.

The benefit of schoolwide online professional development that is prepared by the school administrator is a great opportunity for the teachers to be motivated by the leader who encourages teachers to come up with solid instructional practices to be shared. Furthermore, the best school leader should be the best instructional coach who motivates teachers with detailed feedback and the benefit of his/her experience. Growing organizations flourish with leaders who take a hands-on approach to their business. Prime examples are Bill Gates, who as a CEO was a great computer geek. Steve Jobs also challenged his employees with difficult tasks to fulfill and set the highest expectations based on his own experience. Likewise, the school leader also should be an exemplary leader for his or her employees, not only by being the head administrator but also by being an instructional leader.

Many U.S. school districts are lacking funding for providing good professional development for their teachers in order to update and motivate them. These schools are usually located in the inner-city districts that serve disadvantaged students. Since school budgets in the United States largely are established based on collecting taxes from families who are living in the same neighborhood, the disadvantaged districts are lacking many educational resources and teachers' professional development programs that ideally should be provided by the local school

district. The online STEAM professional development I designed might be a very good resource for the students and teachers who want to implement it at their schools. It may help administrators be creative in recruiting teachers even if they do not have the budget to provide full-scale professional development. The online STEAM professional development might be used to close the gap in economic disparity while the community partnership can stimulate and replicate the educational tools like my STEAM online professional development.

In order to reach the larger education community, the STEAM online professional development might be developed and implemented in the teacher certification programs of universities, and in this way new teachers might be encouraged to use online resources and technology and to connect all STEAM subjects with real-life events. This might be a very effective way to prepare teachers to be open minded toward new educational trends such as STEAM. Furthermore, using and implementing online STEAM professional can be an effective policy-changing tool for schools, universities, and teacher preparation programs in educating individuals through video-based instructional methods.

The overall responses to the effectiveness of STEAM-based online professional development courses as a delivery method for professional development were positive based on data from research participants. Study results also showed that online professional development participants had an overall positive perception of the effects of the course on their beliefs and perceptions regarding their STEAM curricula teaching self-efficacy. As such, I achieved my goal of establishing STEAM-based professional development, which is so unique and gives teachers insights for implementing the common STEAM-based educational practices in their classroom, organizing STEAM-based activities, collaborating with other teachers, and understanding global competition through STEAM-based education.

Furthermore, the STEAM-based professional development course I designed achieved the goal of changing teachers' beliefs and perceptions regarding their STEAM curricula teaching self-efficacy. The results from this study support Bandura's (1977) theory, which indicates that individuals' motivation levels, affective states, and actions are based more on what they believe than on what is objectively true. This theory, applied to the present study, helped guide my exploration of teachers' perceptions, attitudes, and beliefs regarding the online STEAM course I developed for this study. In light of these results, school districts could implement online professional development for any new program, like STEAM curricula, and promote it to teachers and the school community before implementing the new program.

In conclusion, the online STEAM-based professional development course I created seemed to reflect teachers' specific needs for understanding the STEAM curricula with the inclusion and design of the online teacher professional development portal.

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7. Appendices

Appendix A

Pre- and Posttest Survey Questions for Teachers

Please circle your response for each of the questions below.

1. Participant's assigned pseudonym:

2. During the last 18 months, did you participate in any one of the following kinds of professional development activities outside the school setting?

(Please circle yes or no for each item a-e below)

- | | | | |
|----|---|---------|--------|
| a. | Educational technology | yes () | No () |
| b. | 21 st century teaching methods | yes () | No () |
| c. | Globalization in education | yes () | No () |
| d. | Computer skills | yes () | No () |
| e. | STEM or STEAM- based professional development | yes () | No () |

3. Have you ever had any online educational portal experience for any specific training or PD?

(Please circle yes or no below)

() Yes () No

4. What grade level are you currently teaching at your school?

(Please circle your response below)

a. Preschool level b. Kindergarten level c. elementary school level d. middle School level

5. A school-wide science, technology, engineering, arts, and math (STEAM) online professional development course is effective for teachers.

(Please circle your response below)

a. Strongly agree b. Agree c. Neither agree nor disagree d. Disagree e. Strongly disagree

6. A school-wide science, technology, engineering, arts, and math (STEAM) online professional development course gives me great insight into my classroom setting.

(Please circle your response below)

a. Strongly agree b. Agree c. Neither agree nor disagree d. Disagree e. Strongly disagree

7. I could benefit from online STEAM professional development in order to be aware of current resources, publications, and tools related to 21st-century learning styles in the school setting.

(Please circle your response below)

a. Strongly agree b. Agree c. Neither agree nor disagree d. Disagree e. Strongly disagree

8. A school-wide online STEAM professional development course will help me clearly understand the school's mission and vision.

(Please circle your response below)

a. Strongly agree b. Agree c. Neither agree nor disagree d. Disagree e. Strongly disagree

9. Attending an online STEAM professional development course will be more convenient than participating in face-to-face professional development.

(Please circle your response below)

a. Strongly agree b. Agree c. Neither agree nor disagree d. Disagree e. Strongly disagree

10. I could learn some skills to collaborate with other teachers effectively through school-wide online STEAM professional development.

(Please circle your response below)

a. Strongly agree b. Agree c. Neither agree nor disagree d. Disagree e. Strongly disagree

11. I could get more ideas to help organize STEAM-based activities at my school through participating in a school-wide online STEAM professional development course

(Please circle your response below)

a. Strongly agree b. Agree c. Neither agree nor disagree d. Disagree e. Strongly disagree

12. Participating in a school-wide online STEAM professional development course may advance my teaching skills and effectiveness based on 21st-century teaching standards.

(Please circle your response below)

a. Strongly agree b. Agree c. Neither agree nor disagree d. Disagree e. Strongly disagree

13. I could learn more about global competition through STEAM-based education practices by participating in an online STEAM professional development course.

(Please circle your response below)

a. Strongly agree b. Agree c. Neither agree nor disagree d. Disagree e. Strongly disagree

14. I could learn about best practices implemented globally regarding STEAM-based curriculum through participating in an online STEAM professional development course.

(Please circle your response below)

a. Strongly agree b. Agree c. Neither agree nor disagree d. Disagree e. Strongly disagree

15. I would like to learn about STEAM-based curriculum through school-wide online STEAM professional development.

(Please circle your response below)

a. Strongly agree b. Agree c. Neither agree nor disagree d. Disagree e. Strongly disagree

16. I would prefer online STEAM professional development to face-to-face STEAM professional development.

(Please circle your response below)

a. Strongly agree b. Agree c. Neither agree nor disagree d. Disagree e. Strongly disagree

VII. MANDATORY IRB TRAINING documentation: Please attach a copy of your CITI investigator training certificate. Your application cannot be approved without evidence of completion of CITI training. Please check the attached IRB training forms.

I certify that the protocol and method of obtaining informed consent as approved by the Institutional Review Board will be followed during the period covered by this research project. Any future changes will be submitted for IRB review and approval prior to implementation.

Signatures required:

Project Director, Dr. Jane Hudak _____ Date _____

Student Researcher, Guray Taysever _____ Date _____

INSTITUTIONAL ENDORSEMENTS

Your endorsement is requested to assure the Institutional Review Board that your office is aware of the existence and status of this research activity.

Division Chair _____ Date _____

Dean _____ Date _____

Please return to: Institutional Review Board

c/o Veronica Hunt

Office of the Provost

G 353

IRB Chair or Representative _____ Date _____

For further details, refer to text of the Code of Federal Regulations, Chapter 45, Part 46, Subparts A-E in the University Library's Federal Document collection

Appendix B

Informational Letter (Survey Participants)

Greetings Teachers:

I am Guray Taysever, a doctoral candidate in the Interdisciplinary Leadership Program in the College of Education at Governors State University (GSU). I would like to invite you to participate in a research study for my doctoral capstone project. The purpose of this study is to understand the impact of the delivery of a four week online course on teacher perceptions of implementing the STEAM concept into their curricula. The study aims to examine the effect of a Science, Technology, Engineering, Art, Math (STEAM) blended online two week PD on the perceptions, behavior and self-efficacy of teachers in utilizing and implementing these resources in their classroom.

It is my sincere hope that you will participate in this valuable study. The collection and analysis of data from this study will help me to obtain a strong STEAM blended online professional development portal in order to mentor teachers who are willing to be ambassadors of STEAM education practices in the education arena. Participating in this survey about the Blackboard STEAM blended two week PD is entirely voluntary. Participants are being asked to respond to discussion board questions for each module and to answer each question in order to make this study most effective. The Online Blackboard course will take only two weeks, studying each module for each week might take one hour. This pretest and posttest survey will take approximately 10-15 minutes to complete, and all of your responses will be kept completely confidential. There are no risks to participating, and you may stop your participation at any time. Additionally, there will not be any direct benefits to you for participating in this study.

Your assistance is greatly appreciated and invaluable. If you are interested in participating in this study, please click “next” to advance to the next screen and complete the survey. If you have any questions about this study, please do not hesitate to contact me at [REDACTED] or [REDACTED]. Thank you for your consideration.

Best regards,
Guray Taysever
GSU Doctoral Candidate

Appendix C

Letter of Consent (for participants)

Protocol Title

Implementation of the STEAM-Based Curriculum in School Settings Grades Preschool through 8th Grade Using Online Teacher Professional Development: Quantitative Pre-Experimental Design.

Purpose of the Research Study

The purpose of this study is to understand the impact of the delivered STEAM blended online course on teacher self-reported future behavior, perception and self-efficacy of implementing STEAM concepts in their curricula.

What you will be asked to do in the study

If you agree to participate in this study, you will be asked to participate in a 10-15 minute pretest survey. After the completion of the pretest survey you will receive a username and password and some instructional guidelines for the Blackboard online portal in order to have access to STEAM Blended PD. You will be requested to study each module and respond to the one discussion board for each week. After completion of the two week Blackboard online PD, you will be invited to participate in a posttest survey. Data will be collected from pretest and posttest surveys approximately at the end of February. The data, retrieved from the pretest and posttest surveys, will be used to examine the effect of STEAM based online PD on the perception of teachers.

Time required

The Online Blackboard course will take only two weeks; studying each module and responding to questions might take about 45 minutes. This pretest and posttest survey will take approximately 10-15 minutes to complete.

Confidentiality

The records of this research study will be kept confidential to the extent provided by law. Your information will be assigned a pseudonym, in lieu of any personally identifying information. The list connecting your name to this pseudonym will be kept in a locked file in the researcher's office. Records will be destroyed after the conclusion of the data analysis and the student researcher's capstone preparation and defense. If there are any publications or presentations as a result of this study, there will not be any information included that will make it possible to identify any of the research participants. Additionally, your name and pseudonym will not be used in any type of reports.

Compensation

Compensation will not be offered to participants. Participation is voluntary.

Voluntary participation

Your participation in this study is completely voluntary. There is no penalty for not participating. If you decide to participate, you are free to refuse to answer any of the questions asked.

Right to withdraw from this study

You have the right to withdraw from the study at any time without consequences.

Benefits and risks

There are no direct benefits for this study. However, the information collected in this research study could provide a useful new STEAM blended online portal for educators to understand the concept of STEAM as an education practice.

This research poses no risks to you as a study participant.

Whom to contact if you have questions about the study

Guray Taysever, [REDACTED] Email: [REDACTED] or Dr. Jane Hudak,
Professor, College of Arts & Sciences, Governors State University, 1 University Parkway,
University Park, Illinois, Office: [REDACTED] Email: [REDACTED]

Whom to contact about your rights as a research participant in the study

If you have questions about this project, you may contact the Governors State University

Institutional Review Board Co-Chairs: Dr. Praggyan Mohanty at [REDACTED] email:

[REDACTED] or Dr. Renee Theiss at [REDACTED] email: [REDACTED]

Agreement

Your signature below and your decision to respond to the questions in this research study will indicate that you have read and understood the informational letter and you have agreed to participate in this study.

First Name

Last Name

Date