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11/4/2021

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CATHOLIC SCHOOLS AND STEM (SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS): AN EXPLORATION OF STAKEHOLDERS' INTEREST AND PERCEPTIONS OF STEM PROGRAMS IN ELEMENTARY SCHOOLS

By

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A DISSERTATION IN PRACTICE

Submitted to the faculty of the Graduate School of Creighton University in Partial Fulfillment of the Requirements for the degree of Doctor of Education in Interdisciplinary Leadership

Omaha, NE

November 4, 2021

Abstract

To remain competitive in the educational market, Catholic elementary schools are exploring alternatives, such as STEM education, to incorporate into their learning environments. In this qualitative phenomenological study, 16 interviews were conducted in Catholic elementary schools to understand their perspectives on developing and implementing a STEM program. The experiences of a pastor, three principals, two STEM coordinators, six teachers, and four community stakeholders were analyzed. Eight themes emerged: (a) shared leadership, (b) professional development, (c) curriculum and instruction, (d) STEM program evaluation, (e) STEM culture, (f) enhanced interest in innovation, (g) strategic planning, and (h) the COVID effect. Recommendations focus on developing a STEM committee/assigning a STEM coordinator, designing professional development centered on STEM, establishing program evaluation and stakeholders' feedback, engaging in STEM strategic planning, and creating a STEM culture. The findings could help Catholic school leaders to develop and implement a STEM program.

Keywords: Catholic schools, Catholic education, Catholic identity, STEM, STREAM, shared leadership, stakeholder engagement

Dedication

This has been a long, but fruitful journey and I am grateful to the many who have been along for the ride, offering support, words of encouragement, and many prayers. Two of those who have been with me since the beginning are my children, Savannah and Cole. When I first told them that I was working on my doctorate, Savannah was excited because she thought I could start writing prescriptions. She was not that impressed when I told her it was not that kind of doctorate. These two blessings have no idea how much I could not have done this without them. There were many times in the past five years where it would have been very easy for me to withdraw from the program, but it was their love and innocence, in some of the very hardest of days, to help keep me on the path to completing this dissertation.

I want to recognize my parents, Dale and Linda, who have been a rock for me and our family. I do not believe that they ever thought I would be in this position, especially for someone who never really liked school growing up. I ended up as a teacher when I know they thought I must have been kidding, considering I might have gotten a C or two in my elementary school days. I was named a principal, often having to speak in public places. I know they always think, when I come to a microphone, the time when, as a child in the 6th grade, I shook uncontrollably during my presentation of Brazil. I am certain that they wondered what was happening when I switched my major in college, left my first master's program, and started my doctorate. But, for every new adventure for me, they never doubted and reassured that everything happens for a reason.

To my grandparents, Donald and Shirley Trott, to my brother, Brian Trott, and his wife, Kate, to my sister, Jennifer Peek, and her husband, Anthony "Pork," and to my

nieces and nephews, I appreciate your support and checking in with me constantly to see how I was doing in this program. I love my family and my extended family. I am sure Uncle Chuck would have never thought that there would be a doctor in the family!

There are three friends in the whole wide world who would drop just about everything in the world and to be there for my children and me. To Kristy Douglas and Jim and Amanda Armstrong, I hope you know that I am grateful to you and all that you mean to me.

I am thankful for my network of friends who I have met through work or through Creighton. I thank, in particular, Brian and Amanda Pope, Sara Vande Kamp, Jason Kotrba, and Tim Reilly who have been the consummate cheerleaders in this program and in life.

Additionally, I want to dedicate this work to Sr. Rose Mary Collins, SSJ, who passed away in 2014. Sister served as Superintendent of Catholic Schools for the Diocese of Savannah and offered me the position of Assistant Superintendent. We worked together for two years and I know I drove her bonkers, especially when she called out for Jesus, Mary, and sweet St. Joseph in our discussions, but we shared some of the biggest laughs and became great friends. She is truly missed.

Finally, I cannot thank enough a person who was a complete and total surprise—Emily Termotto. Words cannot express how much I appreciate you reading over my work, offering advice, a listening ear, and your constant support. I also greatly enjoy your cooking, especially your Italian sauce, your laugh, and your sweet, kindhearted nature. Your compliments and your positive affirmations, much to my chagrin, have been wonderful and often needed to help keep me going. I thank you for your unconditional love and am looking forward to my next journey—with you. Ti amo!

Acknowledgments

I want to thank and acknowledge my dissertation chair, Dr. Barbara Brock, and to my committee member, Dr. Sarah Wannemuehler. What many do not know is that my original chair resigned after I had written the first three chapters. The Creighton University Interdisciplinary Leadership program professors worked extremely hard in a short amount of time to pair me, as well as some of my colleagues, with a new chair. It was not an easy process for Dr. Brock to get up-to-speed on my work. It was also not an easy process to essentially rewrite the first three chapters. However, she knew where I needed to go with my work and she knew how to put me on the path to success. I enjoyed our conversations about my dissertation and progress, but I also enjoyed talking to Dr. Brock about Catholic education and her experiences. We often found that the world is small and the connections that we had in Catholic education. I appreciate all that she has done for me.

Dr. Wannemuehler probably wondered what she got into when she said “yes” to being a part of my team, but I am so thankful she did. It was wonderful for me to have a friend in Catholic education and a friend who knew what was happening personally to be a steady advocate for me in this program and throughout this dissertation. That was a gift from God! One thing that Dr. Wannemuehler taught me a long time ago during a principal’s retreat was a family tradition of blessing each other before you go (go to bed, go away on a trip, pass away). That is a tradition the Trott’s do in our house. God bless you, Dr. Wannemuehler!

Lastly, there are many who supported me in this journey that I cannot thank enough. I want to acknowledge the Creighton University faculty and staff for their encouragement; the faculty and staffs of St. Gregory the Great Catholic School, St. Peter's Catholic School, St. Hugh of Grenoble Catholic School, St. Pius X Regional School, and St. Mary of the Assumption Catholic School for helping to mold me into a teacher and administrator; the principals and Catholic Schools Office staffs of the Diocese of Charleston, the Diocese of Savannah, and the Archdiocese of Washington for their professional support and camaraderie; and to my friends from the National Catholic Educational Association, especially on the Department of Elementary Schools Executive Committee, who helped me to broaden my horizons in Catholic education. I appreciate the constant care and compassion that Sandra Leatherwood, Sr. Patricia Helene Earl, IHM, Ph.D., and Kenna Alewine have shown me professionally and personally. Finally, thank you to Rev. Msgr. Ronald R. Cellini, pastor of St. Gregory the Great Catholic Church, who gave me permission to pursue this doctorate program, who offered unwavering encouragement, and often stormed heaven with prayers on my behalf. I am sure he asked almost every saint there is to intercede for me—multiple times.

Table of Contents

List of Tables

List of Figures

CHAPTER ONE: OVERVIEW OF THE DISSERTATION IN PRACTICE PROBLEM

Introduction and Background

Over the past decade, the acronym "STEM," which stands for science, technology, engineering, and mathematics, had become a buzzword in the education world. In September 2010, President Barack Obama gave an address called "Science, Technology, Engineering, and Math: Education for Global Leadership." In the speech, he stated,

> The United States has become a global leader, in large part, through the genius and hard work of scientists, and innovators. Yet today, that position is threatened as comparatively few American students pursue expertise in the fields of science, technology, engineering and mathematics (STEM)— and by an inadequate pipeline of teachers skilled in those subjects.

Of the fastest growing occupations within the United States, 80% of them rely on employees having math and science knowledge and skills (Johnson, 2012). Applicants for positions in various industries do not have the competencies in math, computer and problem-solving that employers are seeking (National Research Council, 2011). Most of those roles are being filled from talent that exists from abroad (Johnson, 2012; National Research Council, 2011).

There is a need for workers with experiences in STEM related fields and it is important for the global economy (Buckner & Boyd, 2015; National Research Council, 2011). Most countries have made it a top priority to address the need for a STEM literate generation (Sahin & Top, 2015). Educational policies implemented by the Obama administration addressed the growing concern of students underperforming in the areas of math and science (Johnson, 2012). The policies also focused on failures of the educational system in preparing students for the workforce and was in response to the United States falling behind in innovation as compared to other countries (Johnson, 2012). K-12 education has failed to provide rigorous STEM related programs and adequately prepare students to be able to problem solve (Fan & Yu, 2017; Sahin & Top, 2015). Traditional approaches to education where individual school subjects are taught rather than through an interdisciplinary approach has led to this disconnect (Fan & Yu, 2017).

Exposing students to STEM careers should begin earlier in schools (Buckner & Boyd, 2015). As recently as 2013, a study showed that “unemployed people outnumbered job postings by 3.6 to 1—but that STEM job postings outnumbered unemployed people by 1.9 to 1. This striking statistic indicated that many jobs are going unfilled simply for lack of people with the right skill set” (Buckner & Boyd, 2015). Buckner and Boyd (2015) suggested that moving forward, in K-12 schools, exposing students to STEM skills will generate more students who are interested in STEM-focused programs. In doing so, this approach to education builds the skills and confidence in students to problem-solve and express themselves creatively through STEM experiences, just as they would in a potential career setting (South Carolina State Department of Education, 2020). STEM education helps to generate the attributes needed and is essential for success in the next century (Verner, 2018).

For the past decade, schools have seen an increase in proficiency of student test scores and work in the areas of science, technology, engineering, and math, though the scores continue to fall short of other nations (National Research Council, 2011; Sahin &

Top, 2015; Verner, 2015). Of the 34 countries a part of the Organization for Economic Cooperation and Development, the United States ranks 20th in science and 27th in math (Verner, 2018). Achievement in the areas of science and math among students in the United States remained low in comparison to international communities (Hansen, 2014). To address this concern, Clapp and Jimenez (2016) found that students have shown a greater interest in STEM careers as a primary outcome of being exposed to STEM related skills in the educational setting.

Interest in STEM has gained traction, including within Catholic schools (Hansen, 2014). "STEM-focused schools are a well-established method of choice 'to raise mathematics and science achievement, improve economic competitiveness, increase job prospects for next-generation workers, and support greater opportunities for low-income and minority students'" (Bullock, 2017, p. 629). Therefore, there has been a growth in STEM programs in Catholic schools. The National Catholic Educational Association estimated in 2015 that about half of all the Catholic schools in the United States incorporated some pieces of a STEM education into their academic programs (Zubrzycki, 2015).

Schools across the nation met current educational needs of students through a STEM-focused program and environment (Kloser et al., 2018). In particular, Catholic schools have introduced new educational models (Kloser et al, 2018). "Some Catholic K-8 schools have recently embraced innovative school models, adopting additional foci such as blended-learning, dual language, and STEM" (Kloser et al, 2018, p. 550). Zubrzycki (2015) noted that sciences and the traditional Catholic school teachings and church trends have meshed. Robson and Smarick (2016) further believed that a blending of new and old approaches to instruction may lead to the renaissance of Catholic education. Buckner and Boyd (2015) wrote, “regardless of which career paths students eventually follow, it is important for them to see that a greater understanding of the STEM subjects can enhance their lives” (p. 2). Information revealed that students who were more STEM-literate were able to solve problems and be more engaged and understanding of the world in which they lived (Buckner & Boyd, 2015).

Within a Catholic elementary school, principals are the instructional leaders (Schafer, 2004). It is under their leadership where new academic programs, such as STEM, are introduced and implemented. STEM has helped to open a new pathway for Catholic schools so that they can remain up-to-date and competitive with their public and private school counterparts (Zubrzycki, 2015). STEM education has provided students with the ability to approach real-world problems and solve them with strategies presented in the delivery of instruction (Fan & Yu, 2017).

Catholic school principals developed a STEM program to create an environment where students could problem solve, work collaboratively, and improve their overall achievement (SmartLab Learning, 2021). With discerning parents, Catholic school principals understood that any education in today’s market must come equipped with technology and next generation learning (SmartLab Learning, 2021). How principals did this involved working with the teachers and staff as well as the community to transition the culture of the school. It involved ensuring students had access to the latest educational technology, introducing language into the school that was STEM focused, implementing real life challenges that needed a solution for students to feel empowered, and providing a support network for teachers and students to fully understand STEM (Bates, 2018).

The development of a STEM program and curriculum was dependent upon the principal's leadership style, which affects communication and collaboration among the stakeholders, feedback and building a model of continuous improvement, and redefining the school identity and culture (Buckner & Boyd, 2015; Kloser et al, 2018). The growth of a STEM program in a Catholic elementary school impacted the curriculum and instruction in the schools' learning environment (Buckner & Boyd, 2015). STEM implementation occurred through school leaders who wanted to improve the quality STEM education and by supporting teachers through best practices to promote STEM learning for students (Buckner & Boyd, 2015). For Catholic schools, it was also differentiating themselves from the competition (Zubrzycki, 2015). In this phenomenological study, Catholic elementary schools in dioceses in the eastern United States were analyzed to give a perspective in the leadership of the school administration, the teachers' reactions and willingness to support STEM, and stakeholders assisting in its implementation These findings helped to create an understanding of the relationships in schools, the decision-making process, and stakeholder engagement.

Statement of the Problem

There is a need for Catholic elementary schools in the United States to develop and implement a STEM program. Though some Catholic schools have embraced STEM (Kloser et al., 2018), it is not prevalent in the Catholic educational system. Unfortunately, schools find it difficult to develop because they do not know where to begin or feel that they will not be able to compete with public schools who already offer STEM programs (Mixa, 2021).

For a Catholic school to develop and implement a STEM program, there must be educational reform that takes place. To lead educational reform, there is a need for stakeholders to be a part of the process (Sondergeld et al., 2016). Involved and engaged community stakeholders should assist in the development of a STEM curriculum. According to Bullock (2017), a successful STEM program requires input of stakeholders who can bring resources and technologies to the school setting (p. 630). Some connections with stakeholders led to STEM-related explorations into potential careers for students and job-shadowing opportunities (Basham & Marino, 2013).

One must consider all stakeholders, especially staff, in the STEM development process (Polka et al., 2016). The *National Standards and Benchmarks for Effective Catholic Elementary and Secondary Schools* (NSBECS) suggested that stakeholders for a Catholic school would include the pastor, principal, teachers and staff, parents and students, parish and community members, local businesses, and organizations (Ozar & O'Neill, 2012). It also included the diocesan officials such as the bishop and superintendent (Ozar & O'Neill, 2012). Stakeholders provided valuable feedback and resources to assist in the conversion. According to Kloser et al., (2018), stakeholder engagement led to the successful development of a STEM program at a Catholic elementary school and transformed the learning environment and school identity and culture.

Stakeholders must also be opened to learning new strategies and behaviors in education (Sondergeld et al., 2016). "Engaging the community includes bringing in members of the scientific and engineering community to help coordinate problem-based learning units and sending students out to the STEM community directly" (Kloser et al., 2018). In this process, high expectations for success in a STEM program are established and can help improve STEM programs, that may result in closing achievement gaps and establishing a bar for success (Sondergeld et al., 2016). As the instructional leader, principals need to guide their schools through this transformation to remain competitive in the educational field (Schafer, 2004).

Engaging stakeholders in developing a STEM program for a Catholic school may help to address the enrollment situation (Kloser et al., 2018; Sondergeld et al., 2016). Some Catholic schools have initiated STEM programs in response to the decline in enrollment (Kloser et al., 2018, Zubrzycki, 2015). Across the United States, enrollment has declined in Catholic schools among families who have school-aged children (De Maeyer, 2018). A total of 37% of Catholic schools closed within a forty-year period (Timsit, 2018). Enrollment, or the lack thereof, for Catholic schools appears to be a challenge throughout the United States (De Maeyer, 2018). Rising costs associated with operating a Catholic school have driven families away due to the rise in tuition (Meyer, 2007). Parents are also more discerning of their choice of education for their child. For Catholic schools to be relevant in today's competitive educational market, principals must weigh options that increase the school's exposure and ensure that they are affordable and accessible (Wuerl, 2008). Tools such as the NSBECS help a Catholic school principal to determine their school's program effectiveness and sustainability (Ozar & O'Neill, 2012).

There were challenges that Catholic school principals faced. Pastor interference, lack of direction from the archdiocesan/diocesan Catholic schools office, and lack of resources posed a problem for principals to effectively implement curriculum and instruction changes. Though it is a challenging task, a principal must be transformational and be willing to change the organization (Fernet et al., 2015; Polka et al., 2016).

Purpose of the Study

Research has been conducted on various programs and strategies that have been effective in supporting STEM, there have been only a few specific studies examining the implementation of STEM programs in Catholic schools. The purpose of the study was to explore how Catholic school leaders engage stakeholders in developing and implementing a STEM program.

Research Question

The following research question guided this qualitative study: How do Catholic elementary school principals engage stakeholders in developing a STEM based program?

Aim of the Study

The aim of this study was to create a leadership model that Catholic elementary school principals will be able to adapt within their schools to engage stakeholders in leading STEM curriculum and instruction changes. Developing a STEM program in a Catholic elementary school could boost student interest in innovation and prepare students for future STEM careers. A by-product of a STEM program and environment within a Catholic elementary school may help to keep it competitive and relative in the field of education. For the purposes of this study, STREAM, which includes religion and arts within the acronym, was examined in the context of a K through 8 Catholic school setting.

Methodology

In this phenomenological approach, the lived experiences of stakeholders of STEM certified or approaching STEM certification were important to analyze (Creswell & Poth, 2018). Through their experiences, the researcher had an opportunity to understand the engagement that was necessary for this process to take place at a Catholic elementary school. The relationships between the stakeholders and the stakeholder's direct impact on the school, including from the pastor, the school advisory board or governing board, the parents and parish community, and the students, informed this research. The changes in the learning environment and school culture as well as the impact on standardized testing and assessments were key pieces in the evaluation.

Definition of Relevant Terms

The following terms were used operationally within this study.

Archdiocese: governed by an archbishop and generally a major metropolitan see that is placed at the head of an ecclesiastical province.

Catholic elementary school: An educational institution that typically includes Kindergarten through 8th Grade, but may also include Pre-Kindergarten and exclude 7th and 8th Grades in different settings.

Catholic Schools Office: Administrative office within the chancery of the archdiocese or diocese that oversees the Catholic education; usually headed by a superintendent.

Chancery: Main offices of the local ordinary.

Cognia: a non-profit, non-partisan national accrediting organization that conducts on-site reviews of educational institutions with a commitment to help institutions continuously improve; formerly known as AdvancED.

Cognia STEM Certification: institutions engage in an organizational improvement process with Cognia to become STEM certified and includes measures of quality for the learning environment; evaluative criteria focused on four domains which include STEM Community, STEM Learning Culture, STEM Experiences, and STEM Outcomes.

Corporal Works of Mercy: they are charitable actions where one comes to the aid of others through service, advising, consoling, and comforting.

Diocese: a district under the pastoral care of a bishop in the Catholic Church.

eleot: Effective Learning Environments Observation Tool; tool produced by Cognia and is used to observe the learner engagement and instruction in a classroom environment.

LEGO Robotics: building blocks and other devices that, when designed and constructed, can be used in conjunction with a computer coding program to move the contraption.

Local ordinary: Cardinal, archbishop, or bishop who has been appointed and installed as the head of an archdiocese or diocese.

Makerspace: a communal area that allows individuals or groups to explore, create, and collaborate; has tools and resources for designing and project development.

National Catholic Educational Association (NCEA): Association of Catholic schools nationwide that helps to facilitate professional development opportunities, networking opportunities, and hosts the annual convention for Catholic education.

National Standards and Benchmarks for Effective Catholic Elementary and Secondary Schools (NSBECS): published in 2012 to help provide Catholic schools a guide and assessment tool to review school program effectiveness and sustainability.

Next Generation Science Standards: Science content standards for Kindergarten through 12th graders developed by 26 states and implemented in 2013.

Pastor: appointed by the cardinal, archbishop, or bishop to serve as the clergyman in charge of a parish.

Principal: Spiritual and academic leader of a Catholic school.

S²TEM Centers SC: a network of education specialists focused on economic and workforce development through improvement in PK to 12 STEM education; helps to bring information, support, innovation, and research to the South Carolina educational community, with a focus on PK to 12 grade schools.

STEM: acronym for science, technology, engineering, and math.

STREAM: science, technology, religion, engineering, art, and mathematics curriculum. As in previous definitions, for the purposes of this study, STREAM was examined in the context of a K-8 Catholic school setting.

Superintendent: Oversees the Catholic Schools Office; job description will vary depending on the local ordinary's direction, but will mainly provide support to principals and pastors in Catholic schools.

Title II-A: a grant program through the United States Department of Education that provides funding to help support teachers in instruction; state education agencies oversee the funding process and the allocations to local school districts, who then are required by law to allocate funds to private schools.

Delimitations, Limitations, and Personal Biases

Delimitations of the student included interviewing stakeholders from Catholic elementary schools from the states of South Carolina, Maryland, and New Jersey. Those stakeholders were a pastor, principals, teachers, parents, and community stakeholders. Other delimitations included the type of STEM program within the Catholic elementary school and the communities that the schools served. Catholic elementary schools that have identified that they offered a STEM program, were certified by an accrediting educational agency in STEM, or were in the process of certification in STEM were selected.

A limitation in this study was the small sample size of Catholic elementary schools. There was a lack of available data surrounding STEM education in Catholic schools. Another limitation was the lack of generalizability of findings since the results of this study can be applied to Catholic schools and those who are in the planning stages of a STEM initiative at the Catholic school. The participants' memory and truthfulness in the interview process was a limitation. Additional limitations included access to the participants due to scheduling conflicts and cancellations, availability during the interview process or willingness to participate, and the pastor or principal lack of sharing the study to additional participants. In this qualitative study, the findings could be subject to other interpretations.

I had developed a STEM, or STREAM, program at my current Catholic elementary school since 2014. I acknowledge my personal biases about how STEM was introduced into the school and parish community, and recognize that each school needs to develop a STEM program that serves the needs of its community. I bracketed my biases through reflection and recording some of my own thoughts through a journal and making separate notes for myself. My intent was to identify implementation strategies that other Catholic elementary schools can adapt to their needs as they develop STEM programs.

The Role of Leadership in this Study

A Catholic school principal must be a transformational leader to effectively introduce changes to the academic program. According to Haslam et al., (2011), a transformational leader needs to be one with the people who they serve. A transformational leader connects with the stakeholders through love-driven leadership (Lowney, 2003). The love-driven leadership model functioned on developing untapped potential and greater love of others than use of fear in leadership (Lowney, 2003). According to Lowney (2003), a leader who expressed an appreciation for the gifts and talents that others are willing to share with the school witnessed greater program development and building of resources within their school. In addition to expressed appreciation, a leader who can communicate a shared vision and understanding of the mission helped to create a sense of staff wanting to work, not just coming to work (Lowney, 2003). Engaging others and building shared identity resulted in an environment where others care for one another and care about their work. This shared identity helped to build up the team and developed a common focal point to make changes to the school's academic program.

For a leader to be effective in their position as a Catholic elementary school principal, they took time for themselves (Lowney, 2003). A principal also needs to understand their role in the school and community (Lowney, 2003; Schafer, 2004). They contemplate their actions and how their decisions benefited stakeholders. Being contemplative in action enabled them to refocus throughout the day (Lowney, 2003). Reflective-in-action and in-the-moment reflection have components of the practice of contemplative in action (Dickel, 2011; Johnson, 2015). Taking time for themselves helped principals to reflect and refocus.

Catholic elementary school principals can also reflect through a strong prayer life (Schafer, 2004). Prayer allowed principals to reflect on their work and self-evaluate what was next. Prayer helped principals to make changes to their work and to prioritize and organize their actions. Principals envisioned what needs to happen next for the success of a program through prayer.

Mutual social influence was where people agreed on and strived for what was important and focused on the same goals (Haslam et al., 2011). The concept of the core issues of social influence, which are the source, the target, and the content, applied to engaging stakeholders (Haslam et al., 2011). Facilitating collaboration and a shared identity in leadership are key, but leaders needed to understand how people collaborated in their environment. Through the concept of self-stereotyping, the shared identity of the stakeholders in a Catholic elementary school was expanded if it was given attention to the foundations of social identity at the personal and social/political level (Haslam et al., 2011). As the social identity and values are established, the shared identity of us through these influences held more power (Haslam et al., 2011). Motivation developed a deeper sense of team and helped generate a greater social influence.

Significance of Dissertation in Practice Study

For Catholic schools to remain relevant in today’s educational field, it was imperative that they evaluated, developed, and implemented innovative academic and interdisciplinary programs that discerning families sought for their children (Wuerl, 2008; Zubrzycki, 2015). With the introduction of term STEM in 2001, but receiving more focused attention in 2010, Catholic elementary schools began to embrace this approach to curriculum and instruction (Clapp & Jimenez, 2018). As STEM continued to build, and more careers centered around STEM developed, foundational components, including the engineering design process, in the elementary level were as important as it was in the upper levels of education (Sondergeld et al., 2016).

STEM is a needed shift in Catholic elementary schools to help prepare students for STEM oriented careers. A STEM program provides students with opportunities to collaborate and solve real world and complex problems (SmartLab Learning, 2021). Establishing a STEM program in a Catholic elementary school results in a cultural and mindset shift and students have more opportunities to take ownership of learning (Kloser, et al.; Meeder, 2017). In order to create this shift, principals need to engage the school community members, especially during implementation.

The implementation process takes time and patience. Teachers are an instrumental component to the success or failure of a STEM program. Teachers should feel confident in their delivery of a STEM program. However, for them to feel confident, they must be supported through professional development and opportunities to learn and grow together in STEM. Teachers will have a better understanding of what is expected and how to introduce STEM into their classrooms through internal and external resources, including through STEM consultants, STEM field experts, and experienced STEM instructors or coordinators. Additional stakeholders, such as pastors, parents, school advisory council members, and community members, help to lay the vision for the STEM program and assist with the implementation process. Principals help to bring these stakeholders together to develop the strategic plan for STEM, which should include a timeline for implementation.

Summary

Students in the United States continued to underperform on internationally recognized assessments, especially in the areas of mathematics and science. However, STEM education continued to gain momentum within the K-12 educational setting due to policymaking, STEM initiatives with community partners, and STEM-focused school programs. With greater exposure to STEM education, there was an increase in STEM interest among students as well as meaningful STEM experiences that helped to build a capacity for solving complex, real-world problems. There was a growing sense of urgency that, to compete in the global economy and to have future generations ready for employment, STEM literacy and education were paramount to the success of the country's economic well-being. With the visionary leadership of Catholic school principals, Catholic elementary schools were integrating STEM areas into their curriculum and academics, with the support of stakeholders, to produce 21st century critical thinking learners who were STEM career ready.

The problem is that there is a continued need for Catholic schools to develop and implement a STEM program. This study was created to explore how Catholic school leaders engage stakeholders in developing and implementing a STEM program. Its aim was to help to develop a leadership model that Catholic elementary school principals can utilize to lead a STEM initiative within their own school communities. Principals, through transformational leadership, can guide the STEM shift with stakeholder support and help to keep their Catholic schools relevant in today's educational field.

CHAPTER TWO: LITERATURE REVIEW

Introduction

To stay current and competitive in the educational market, Catholic elementary schools looked to develop and implement a science, technology, engineering, and math (STEM) program (Zubrzycki, 2015). Some Catholic elementary school principals, as the leaders who guide educational reform, introduced STEM as a way of enticing current and prospective families (Clapp & Jimenez, 2018; Johnson, 2015; Kloser et al., 2018). The educational reform focused on implementing a quality STEM program and principals evaluated best practices through researching STEM (Buckner & Boyd, 2015).

The literature review focused on a principal as the leader and STEM in the educational system, including in Catholic education. Research connected to this study addressed thematic areas of Catholic school principals as a decision-maker and transformational leader, STEM education, STEM in elementary schools and Catholic schools, and stakeholder engagement and changes in STEM perception. This research also evaluated articles that were related to STEM curriculum and instruction which includes the history of STEM in Catholic schools, STEM prior to 2010, and STEM from 2010 to present. The aim was to present the information to support the challenge that Catholic elementary school leaders faced in the implementation of STEM curriculum and instruction.

Leadership Literature

Decision-Making

Catholic school principals' decision-making abilities and their ability to manage change affected the schools' capacity to face challenges moving forward. According to Schafer (2005), "the school principal is generally identified as a primary decision maker in both public and private schools" (p. 230). Polka et al. (2016) studied events that impacted Catholic school principals' leadership practices in the United States and Canada. Their quantitative research was aimed at assessing whether gender, age, nationality, or years of experience in leadership were a determining factor in a principal's decision-making or problem-solving process (Polka et al., 2016). Those with significant years of experience used a decision-making approach based on the impact of the decision on those who have worked together the longest (Polka et al., 2016). Principals within that same range tended to use the satisficing approach, where alternatives are evaluated until one is generally accepted by most of the group, because it is the one solution that most can agree (Polka et al., 2016). The seven approaches evaluated for decision-making/problem-solving were classical, incremental, garbage can, shared decision-making, satisficing, mixed scanning, and political.

Decision-making was considered in a previous study conducted by Cotton et al. (1988) where employees played a participative role in the work environment which resulted in different outcomes. Results showed that participation was multidimensional (Cotton et al., 1988) and included participation in work decisions, consultative participation, short-term participation, informal participation, employee ownership, and representative participation (Cotton et al., 1988). The results showed that information participation and employee ownership were effective in terms of both productivity and satisfaction but there is no simple answer for whether PDM is effective (Cotton et al., 1988). Similar research by Schafer (2005) revealed that all members of the team should be responsible for helping to make important decisions. Schafer (2005) referred to it as a consensus.

Additionally, Cotton et al. (1988) showed that "information participation is more effective in increasing satisfaction with supervision and the work itself than with other facets. Representative participation increases the satisfaction of representatives more than it does that of other workers" (p. 16). Curriculum changes were more effective if the staff can be brought in on curriculum decisions and be provided vital information. According to Schafer (2005), an important part of leadership was having developed positive working relationships. An organization was more effective through collaboration and team building (Schafer, 2005). Alternatives were discussed, and the working relationships colleagues have with one another led to effective changes in curriculum and satisfaction among its implementation and work experiences. Cotton et al. (1988) also suggested that other effects include the organizational setting. There is greater effectiveness in direct forms of participation with long-term forms of participation being more effective than short-term (Cotton et al., 1988). As Cotton et al. (1988) addressed, the organization played a role in the decision-making that takes place from the leadership.

Another key component to decision-making came from Sims and Keon (1999). They focused on ethical decision-making on the perceived organizational environment. Two pieces came from this qualitative study. The first is that the perceived organizational environment related to the ethical decision made by the leader (Sims & Keon, 1999). This organizational influence played a significant role in how leaders made their decisions and how the employees reacted to the decision. The second item that resulted was expectations of the supervisor impacted decisions made by the employees themselves (Sims & Keon, 1999). Overall, it was noted in this research that consistently reinforced supervisor expectations, informal policies, and formal policies led to employees more likely to follow those expectations regardless of the situation (Sims & Keon, 1999). Principal expectations impacted how teachers accept curriculum changes.

Transformational Leadership/Job Satisfaction

Leadership in a Catholic school can impact how curriculum and instruction are implemented. This is supported by Meeder (2017) who noted that a leader is effective by being well educated about the broad information of STEM education. The school leader needed to understand which resources and STEM ideas are available to move the school in the direction of STEM (Meeder, 2017).

Similar findings by Schafer (2005) revealed that leadership is best managed through persuasion and inspiration. Through this approach, the leader can impress upon the followers obedience, respect, loyalty, and cooperation (Schafer, 2005). Schafer (2005) argued that this is a non-coercive relationship with the leader and followers.

Fernet et al., (2014) conducted a study aimed to understand the motivational factors between transformational leadership and how employees functioned in the work environment. Two cross-sectional studies were conducted with the second study focused on high school principals and vice-principals. “The results revealed that transformational leadership behaviors could play a more distal role than work organization factors by acting simultaneously on perceived job resources and job demands” (Fernet et al., 2014, p. 23). The results also suggested that transformational leadership was dependent on a “manager’s ability to act positively and proactively on perceived job characteristics, which translate in turn into motivational states that either foster or hinder optimal job functioning” (Fernet et al., 2014, p. 28).

Dhingra and Punia (2016) focused their study on the culture of the organization and its relationship with employees' change readiness. Though this study was completed in India, its implications were generalized into other work environments for it evaluated how an organization's culture contributed to an employees' willingness to change (Dhingra & Punia, 2016).

Both Dhingra and Punia (2016) and Fernet et al., (2014) suggested that motivation can lead to job satisfaction. This is supported in another article, written by Saleem (2015), where motivation rather than organizational politics helped with changes that take place in the work environment. Saleem (2015) investigated leadership styles and their impact on job satisfaction. Responses were collected from university teachers in Pakistan, but the results can be implied in other organizational settings. The findings showed that job satisfaction was positively impacted through transformational leadership (Saleem, 2015). In contrast, the findings revealed that transactional leadership had a negative impact on job satisfaction (Saleem, 2015). The results also concluded that a transformational leader encouraging honesty and fairness helped to reduce perceptions about organization politics and created a positive work environment. (Saleem, 2015). It can be argued that if a Catholic school principal were to institute curriculum change, it can be implied that their ability to be positive and proactive in that change will assist the teachers in the process. This is supported by Schafer (2005) who noted positive relationships are important to leadership.

Dhingra and Punia (2016) showed that there is an increase in openness and dealing with confrontation through positive relationships. Leaders can manage change in the organization more effectively and employees' willingness to change increased

(Dhingra & Punia, 2016). It can be argued then that principals led curriculum and instructional changes through building positive relationships. Similarly, Schafer (2005) argued that relationships are built by being aware of the many interrelationships and intrarelationships within the organization. Understanding the relationship meanings and their identities are created when employees within the organization work together (Schafer, 2005). It can be argued that the likelihood of teachers being content with the changes and having input on changes to the curriculum and instructional practices through relationships led to better job satisfaction from them.

Bass (1990) laid the foundation for transformational leadership in his analysis moving away from transactional leadership to transformational leadership. "Superior leadership performance—transformational leadership—occurs when leaders broaden and elevate the interests of their employees, when they generate awareness and acceptance of the purposes and mission of the group, and when they stir their employees to look beyond their own self-interest for the good of the group" (Bass, 1990, p. 21). He also acknowledged that relationships through transformational leadership help contribute to the organization and are more effective (Bass, 1990). Catholic school principals must work towards being charismatic and develop relationships to promote change as a transformational leader.

Stakeholder Engagement

The entire school community played a critical role in supporting STEM (US DOE, 2015). The community promoted high quality STEM learning experiences through exposure and equitable access (US DOE, 2015). This is supported by Kloser et al. (2018) who stated that a Catholic elementary school community that begins a STEM focus must have stakeholder engagement. It is demonstrated by teamwork among stakeholders (Kloser et al., 2018). These included teachers, administrators, parents, and bishops (Kloser et al., 2018). The relationships were cooperative between the educators and bishops, the student and teacher, and the school's physical environment (Kloser et al., 2018).

In Kloser et al. (2018), the case study addressed engaging the community, especially those in the scientific and engineering field, to help develop problem-based learning lessons while also providing opportunities for students to go out to the STEM community to learn. The US DOE (2015) supported this when it suggested stakeholders come together to transform STEM education through goal setting. The local community can address STEM strengths and biases in the educational system so that they are working together to meet the needs of their diverse student population (US DOE, 2015). Uniting the teachings of the Catholic faith, Kloser et al. (2018) found that the stakeholders set goals to help students be prepared for the 21st century. Kloser et al. (2018) argued that stakeholders must respond to the social justice needs and that this was where STEM and Catholic identity can work collaboratively to solve problems and were creative in doing so. Kloser et al. (2018) stated that stakeholders can create a STEM program through a Catholic lens. Overall, Kloser et al. (2018) found that Catholic identity was a central component within Catholic STEM education and led to greater buy-in from stakeholders.

In another study, Odhiambo and Hii (2012) found that the leadership helped drive stakeholder engagement. The principal was highly regarded by the stakeholders as the leader of the school (Odhiambo & Hii (2012). An effective school leader was associated with an effective school (Odhiambo & Hii, 2012). The relationship was inseparable (Odhiambo & Hii, 2012). In their qualitative study, they found that the power of the principal helped to drive certain aspects of the school. One of them was that power was valued by stakeholders (Odhiambo & Hii. 2012). Utilizing that power, it can be argued that Catholic school principals needed to be innovative and to look towards the future for improvement, development, and progress of the school. Crucial to school leadership was building strong interpersonal relationships and a team environment (Odhiambo & Hii. 2012). Relationships in the team environment helped to improve and maintain high standards (Odhiambo & Hii, 2012).

Literature about the Professional Practice Setting

STEM Education

STEM Prior to 2010

Education constantly evolved (Blackley & Howell, 2015). Prior to STEM being addressed, educators, legislators, and American presidents have attempted to draw attention to the need for students to learn about and experience the sciences (NSB, 2010). President Roosevelt wrote a letter to the United States Office for Scientific Research and Development in 1944 asking if more can be done to prepare the youth through educational programs and develop scientific talent (NSB, 2010). The Hechinger Report (2011) pointed to the Soviet Union’s 1957 launch of the Sputnik I as a key moment in the American movement to push forward educational programs in the sciences. The same report emphasized that, in response to the Sputnik’s launch, funding for the National Science Foundation (NSF) doubled to increase teacher training and enhance the science curriculum (Hechinger Report, 2011). From there, years of budget funding and slashing for science education took place (Hechinger Report, 2011). A result was a lack of success for science programs due to poor curriculum structure and lack of training for teachers (Blackley & Howell, 2015).

It was in the late 1990s and early 2000 that a renewed energy was placed on science. The introduction of the National Science Education Standards in 1996 and American companies focusing on scientific talent aided in this focus (Hechinger Report, 2011). In 2000, Astronaut John Glenn was commissioned to address math and science programs in Kindergarten to 12th grade classrooms (Hechinger Report, 2011; United States Department of Education, 2000). The authorization of the No Child Left Behind (NCLB) Act of 2001 took the focus from science and placed it on math and reading programs (Hechinger Report, 2011; Johnson, 2012). Barnum (2017) found that the NCLB spent too much time on attempting to improve standardized test scores, and not much else. Amid the NCLB, it was argued that two events took place in 2007. First, the National Science Board (NSB) issued a report that addressed the concern about the lack of STEM education within the United States (2007). The report also expressed that the country had become too dependent on outside STEM talent (NSB, 2010). Second, the National Academies issued a report called "Rising Above the Gathering Storm" (Hechinger Report, 2011). In it, the report described how the United States, to advance in the 21st century, must strengthen math and science education (Hechinger Report, 2011; National Academies, 2007). Many of the science initiatives and recommendations from the reports went unfunded until the Obama administration advanced the STEM initiative in the American educational system.

STEM in 2010 to Present

According to Johnson (2012), in 2009, President Obama established STEM as a priority in the American educational system. The NSB report laid the groundwork for the STEM priorities by recommending rigorous standards in STEM and teacher preparation, focusing on STEM innovators, allowing access to college-level or dual-enrollment opportunities for students, initiating professional development opportunities for school staff, incorporating partnerships with those in the STEM fields, and using a variety of assessments to identify student achievement (NSB, 2010). Johnson (2012) found that this report came off the heels of a similar report issued by The Carnegie Foundation in 2008 that addressed the STEM crisis. This report stated that STEM must focus on high levels of math and science learning through common standards that are clear and higher ordered that align with various assessments (Johnson, 2012). Johnson (2012) also noted that, in the report, STEM can be achieved through improved professional learning and development, school management, and instruction delivery, especially in the areas of math and science. Government funding for STEM initiatives began in 2011 (Johnson, 2012). In that year, the federal budget had nearly four billion in STEM education reform (Johnson, 2012). Johnson (2012) also noted that, in that budget, there was over four billion for a Race to the Top Fund initiative that made STEM as the only education priority. With those financial commitments, the NSB (2010) noted that the nation's success in STEM and nurturing STEM programs was on the shoulders of the education system.

To support teachers and to identify STEM concepts that students should learn by the time they graduate high school, two important educational pieces were introduced.

The *Framework for K-12 Science Education* (National Academies, 2012) provided practices used in science and engineering that students could replicate in the learning environment. In 2013, the Next Generation Science Standards (NGSS) were introduced to the educational system and reformed science education into the 21st century (Sadler & Brown, 2018). Pruitt (2015) found that the NGSS included three dimensions of scientific and engineering practices, crosscutting concepts, and core ideas. Engineering standards and practices were strengthened through NGSS, and there was alignment to core math, science, and technology subjects as well as with core English-Language Arts standards (NGSS Lead States, 2013). According to Pruitt (2015), many states found the NGSS advanced scientific literacy. It has helped to bring the wonder of science back into the classroom (Pruitt, 2015). Though not all states have adopted NGSS, Pruitt (2015) found that there are many school districts adhering to NGSS, ignoring state politics. The result was that NGSS is influencing science education throughout the country (Pruitt, 2015) and can be argued that it has made its way into Catholic education. The NGSS have helped to move forward the STEM initiative.

In 2015, the United States Department of Education issued a report called *STEM 2026: A Vision for Innovation in STEM Education.* It laid a vision for the future of STEM education, from early childhood to 12th grade (US DOE, 2015). “STEM 2026 envisions high-quality, culturally relevant STEM learning experiences for every child and young person” (US DOE, 2015, p. 6). The report included engaged learning communities who provide accessible activities for all types of learners where play and risk are welcomed (US DOE, 2015). The report argued that educational experiences should be interdisciplinary, flexible, and inclusive while solving grand challenges (US DOE, 2015).

The US DOE (2015) suggested that learning through STEM be innovative and accessible and that the environment should promote diversity and opportunity in STEM. Similarly, Buckner and Boyd (2015) found that children should be introduced to STEM, formally and informally, early in their education to encourage the innate interest in the exploring their world. STEM has also opened conversations that have helped to change perceptions. A summit held in the summer of 2018 at the White House with the Trump Administration expressed the need to make stronger connections between educational and work experiences, refocus on paths to entrepreneurships and innovation, engage in applicable computer science experiences across the curriculum, and open better access to STEM (The White House, 2018).

Changes in STEM Perception

The United States is seen as a leader in the global world market, but it is being challenged by other countries (Achieve, 2012). According to Johnson (2012), the United States is behind other countries, such as China, in innovation. To solve this issue, Buckner and Boyd (2015) stated that all students need to be exposed to STEM and STEM fields. In that article, Buckner and Boyd (2015) found that the United States was relying on the educational system to prepare students to become engineers, scientists, and mathematicians who can address the problems both today and tomorrow. However, Meeder (2017) argued that gaps in the educational system have existed in attitudes and perceptions of academic achievement. The NSC (2010) supported this by noting that academic achievement was not always supported through the attitudes of educators, policymakers, parents, students, and students' peers. Society almost always applauded talent, but generally in the form of athletics and fine arts (NSC, 2010). In contrast, NSB (2010) noted that intellectual talent is met with ambivalence.

According to Meeder (2017), discrimination has also affected the development of STEM. There have been some barriers for women and minorities in being successful in STEM (Meeder, 2017). They are underrepresented in STEM fields (Meeder, 2017). Similar findings in the US DOE (2015) stated that school districts and states must be challenged to promote best practices and make them accessible to all learners, including having participation from those who are historically underrepresented in career and technical education (CTE) programs. The US DOE (2015) argued that STEM must be developmentally appropriate and be introduced into early childhood education. It further stated that, to change perceptions, STEM must engage all students, no matter the ethnic, social, cultural, or economic backgrounds (US DOE, 2015).

According to Meeder (2017), evidence suggested that underrepresented students will move away from science and engineering. They will be attracted to other professions (Meeder, 2017) because of the lack of opportunities in STEM. Meeder (2017) also found that there was a lack of interest in STEM among females and minorities. STEM should not just be for white males and those of Asian descent (Meeder, 2017). Implicit biases needed to be removed. “Implicit biases that adversely affect certain groups of individuals are particularly challenging to combat since, unlike explicit biases that involve consciously held beliefs and attitudes about a particular group, implicit bias ‘is activated automatically and unintentionally, functioning primarily outside of a person’s conscious awareness’” (US DOE, 2015, p. 8). This is supported by Buckner and Boyd (2015) who noted that implicit biases can be removed by leaders who wish to see STEM education improve in their schools and that all students within it have access to rigorous learning opportunities. STEM should not just be for some but be afforded to the general student population (Meeder, 2017). As Meeder (2017) wrote, “STEM education is a mix of three subgoals: build STEM literacy among all students, cultivate interest and talent to launch a significant percentage of students towards STEM expert careers, and create a safe and challenging environment to attract students into STEM expert pathways who otherwise might have been left behind” (p. 19). For all students to be engaged in STEM learning and literacy, perceptions need to be knocked down and avenues need to be opened, which set up STEM paths for schools (US DOE, 2015).

STEM Education in Catholic Schools

History of STEM in Catholic Education

There was much written about Catholic education embarking in the new millennium through 1990s and 2000s, such as *Renewing our Commitment to Catholic Elementary & Secondary Schools in the Third Millennium* (2005), but no document specifically addressed the sciences. Despite this, in an article by Denig and Dosen (2009), the authors remarked that Catholic education has continued to evolve and made changes to its overall programs. Denig and Dosen (2009) noted that each Catholic school develops its own mission and vision based on the community it serves. Similarly, Jacobs (1998) wrote that Catholic schools develop a framework from the mission and vision where the same basic educational goals apply for each student. Those educational goals were immersed in the Catholic school organization and motivated high student performance (Jacobs, 1998). Jacobs (1998) noted that what Catholic schools have done for years was provide educational experiences and work-related experiences, unknowingly being STEM minded.

It would not be until the introduction of the *National Standards and Benchmarks for Effective Catholic Elementary and Secondary Schools* (NSBECES) in 2012 that provided Catholic schools with a foundation to specifically address academic excellence. “The essential elements of ‘an academically rigorous and doctrinally sound program’ mandate curricular experiences—including co-curricular and extra-curricular activities—which are rigorous, relevant, research-based, and infused with Catholic faith and traditions” (NSBECES, 2012). Garcia-Huidobo (2017) found that the standards were general standards in excellence for Catholic schools and should help support curriculum development. The standards, which are not a curriculum, could be used to address Catholic school academic programs, including the sciences. Prior to the NSBECES, Common Core State Standards (CCSS) were adopted in 2009. It was worth noting, according to Garcia-Huidobo (2017), that the United States Catholic Conference of Bishops (USCCB) said that CCSS should neither be adopted or rejected but reviewed in the Catholic educational system. During that time, even with the NSBECES and CCSS, not much was done in the way of curriculum conversations among Catholic scholars (Garcia-Huidobo, 2017).

With much surfacing in standards and benchmarks, academic excellence and core curricular practices, and presidential focus on STEM the late 2000s, the National Catholic Educational Association (NCEA) embarked on a STREAM initiative in 2014. Using components of the NSBECES, it helped to draw attention to STEM in Catholic education (Zubrzycki, 2015). Though no specific standards exist for STEM or STREAM in

Catholic education, the NCEA brought together experts and best practices of STREAM existing in Catholic schools (Zubrzycki, 2015). In 2015, it was reported that at least half of all Catholic schools in the United States had some element of STEM, or STREAM, in its program (Zubrzycki, 2015).

Catholic Identity and STEM

One area of curriculum and instruction that was beginning to appear more frequently in Catholic education was Science, Technology, Engineering, and Math (STEM) education. Unfortunately, it was nearly five years after the Obama administration's announcement that the National Catholic Educational Association (NCEA) addressed STEM, or STREAM, in a national conference (Johnson, 2012; Zubrycki, 2015). According to Kloser et al. (2018), as Catholic schools began to introduce this educational trend, it was first challenged with integrating Catholic identity into the program and STEM into the religious environment. How schools integrated STEM into their schools was dependent upon the school community and varied regionally (Kloser et al., 2018).

Similar research by Convey (2012) stated that important components of a Catholic school were its faith community and culture; the Catholic faith must be evident in a Catholic school community. Convey (2012) wrote that Catholic schools shared a sense of community, and it positively affected the schools' quality of life and the schools' effectiveness.

According to Kloser et al. (2018), Catholic schools that chose to adopt STEM are faced with the addition of a role identity. To assist with this, Johnson (2012) wrote about the implementation of STEM and the building of a STEM partnership using Fullan's change theory. Fullan's change theory proposed four broad phases in the change process: initiation, implementation, continuation, and outcome (Nair, 2019). Johnson (2012) addressed building a STEM educational partnership through policies and a concerted effort to reform education (Johnson, 2012). Results provided that implementation of a STEM policy does encounter barriers because of timeliness, differing agendas, and the interest (or lack thereof) of partners. Sustainable networks must be developed through leadership to ensure that the STEM curriculum and instruction reform that takes place goes beyond the initial period (Johnson, 2012). This was supported by Berube (2014) who wrote that STEM education will develop talents that are needed to compete globally, far beyond what takes place in the classroom. As STEM education continues to be a conduit for curriculum and instruction change in Catholic schools, school leaders must account for an obtainable timeline, engagement from stakeholders, and a network of partners (US DOE, 2015).

According to Cook (2015), the heart of Catholic education was Catholic identity. Ensuring that a Catholic elementary school has Catholic identity was a characteristic of a principal as spiritual leader (Schafer, 2004). This was supported by Weiss (2007) who noted that the principal, as the spiritual leader, was the one who promoted the school's mission. The principal exuded good leadership through guiding principles and stayed focused on the religious and educational formation of each student (Weiss, 2007). Weiss (2007) further stated that the spiritual leader then ensured that the coursework reflected the Catholic faith and continued to teach an understanding of the world that sustained Catholic heritage.

In a related study, Boyle et al. (2016) analyzed the role of a Catholic school principal as both an instructional leader and faith leader. "Catholic school principals have a multidimensional role that includes some of the following aspects: instructional leader, financial manager, development and fundraising director, public and alumni relations facilitator, faculty supervisor, student recruitment director, and disciplinarian" (Boyle, et al., 2016, p. 299). In addition, Schafer (2004) had earlier noted that school leaders must also have a vision, understand policy and governance, be effective in communications, be organized, understand human resources and personnel management, develop staff, and conduct educational research and planning. Principals in Catholic education must encompass those characteristics but maintain a direct focus as faith leaders.

According to Cimino (2007), school leaders led others to holiness and create a moral environment. Boyle et al. (2016) supported this by noting the schools' viability was linked to the leaders of the Catholic school ensuring Catholic identity and the Catholic faith are evident. Schafer (2004) also wrote that the faith development of the teachers and students was incumbent upon the Catholic school principal. As the spiritual leader of the school community, Schafer (2004) also noted that principals were responsible for building the Catholic community, providing guidance for moral and ethical development of students, and creating a clear mission statement. Convey (2012) affirmed this by stating that a Catholic community, under the guidance of the principal as a faith leader, when functioning at a high level, is effective in producing positive relationships which can lead to moral outcomes.

Data-Informed Instruction

For Catholic schools to continue to survive in the future, changes must take place in curriculum and instruction. In an article by Niemeyer et al. (2016), they wrote that if Catholic schools wish to remain viable options in the educational market, they must become comfortable in revealing academic achievement data to the public. Catholic schools must also be focused on collecting and analyzing data to drive instruction (Niemeyer et al., 2016). Cimino (2010) had earlier affirmed this by recognizing the need for Catholic schools and principals to market their product in the ever-increasing diversity in the educational field. Kloser et al. (2018) addressed that STEM had marketing potential to help drive enrollment.

In a related article, Roach et al. (2008) conducted a literature review on aligning curriculum and assessments so that teachers are focusing on student achievement and addressing academic outcomes. Roach et al. (2008) noted that student achievement was facilitated through a framework designed by school leaders and teachers that examine instruction and assessments to ensure that the content is observable, measurable, and reliable. Moreover, Niemeyer et al. (2016) understood that the teachers were an important part in driving instruction by utilizing the available data. They noted that teachers must be trained on how to collect data, different types of data collection methods, and the appropriate use of the data collection (Niemeyer, 2016). Teachers must have step by step instructions and be coached on data collection (Niemeyer, 2016).

Teachers making changes to the way they instruct and incorporating curriculum more effectively into the learning environment will help student engagement (Roach et al., 2008). In Roach et al. (2008), they suggested that untapped potential existed by aligning concepts through regular reviews of instruction data and responding to instruction dilemmas faced by teachers. Niemeyer et al. (2016) supported this by noting Catholic schools must begin to adjust the way data is collected and it is the leaders and teachers who must understand the practices involved to help enhance a students' educational experience. Principals needed to encourage teachers to practice using evidence-based assessments, analyzing it, and applying interventions (Niemeyer et al., 2016). Additionally, Kloser et al. (2018) wrote that Catholic schools have traditionally had high expectations for all students along with a strong core curriculum, which has made it more of a challenge to use tracking as a way of collecting data. Nonetheless, it can be argued that the framework on how to drive instruction using data needs to be addressed by the leaders and teachers in Catholic schools (Kloser et al., 2018).

Curriculum

According to Buckner and Boyd (2015), curriculum and instruction changes are ever-present in education. How schools choose to incorporate these elements and move with the changes was dependent on the leaders and teachers. Garcia-Huidobro (2017) conducted a literature review on curriculum in Catholic schools and how they were making a difference for students. The literature review helped to draw attention to curriculum conversations and discussions on Catholic schools' innovation and academic excellence (Garcia-Huidobro, 2017). The article addressed that curriculum discussions among Catholic education researchers have begun to change (Garcia-Huidobro, 2017). Future conversations about curriculum and perspectives must be open in Catholic education. "Only these dialogical stances can assure that future Catholic schools will neither be gated communities focused on persevering a narrow identity nor secularized institutions with excellent academic results but an unrecognizable Catholic distinctiveness" (Garcia-Huidobro, 2017, p. 92).

Problem-Based Learning

Problem-based learning has made its way into the school environment and has helped teaching to become more creative (Berube, 2014). Problem-based learning, also referred to as problem-based inquiry, fosters STEM education where students work collaboratively and engage learners in higher order thinking (Berube, 2014). Berube (2014) argued that problem-based learning helped to close the achievement gaps in math, science, and technology of marginalized students through a more unique learning environment. Students work to solve problems on their own, receiving support and guidance from their teachers (Berube, 2014). Berube (2014) noted that problem-based learning does not take away from content learning. It takes content information to the next level and asks students to apply their knowledge to what was learned in the classroom (Berube, 2014).

Summary

Catholic school principals are charged with being the spiritual and instructional leader of the Catholic elementary school. Principals have aimed to shift curriculum by researching and implementing best practices using such foundations as the NGSS, NCSBECES, and CCSS. Documents from the United States Department of Education on STEM and the STEM vision as well as more recent summits, such as White House State-Federal STEM Education Summit in 2018, have aided Catholic elementary schools in implementing STEM programs. The introduction of STEM has increased in recent years in Catholic education. Principals looked to integrate both the Catholic identity and the

STEM focus into the school environment. Principals needed to recognize community and stakeholder motivation to lead these changes. As a transformation leader, principals developed relationships with stakeholders to move the school forward into the future through innovation and data-informed decisions.

CHAPTER THREE: PROJECT METHODOLOGY

Introduction

The purpose of this phenomenological dissertation in practice study was to explore how Catholic school leaders engage stakeholders in developing and implementing a STEM program. The research examined the interest in STEM education in Catholic schools across the elementary grade levels. A phenomenological approach was used to help explore a problem (Creswell & Poth, 2018). This study looked at leadership and at the stakeholders' perceptions and interests in implementing a STEM program within Catholic elementary schools. To achieve this aim, data were collected through a qualitative, phenomenological methods approach by surveying pre-kindergarten through sixth grade teachers and/or leaders about their attitudes and perceptions about STEM. Interviews with teachers and principals in various STEM program environments were conducted. This approach was taken to provide a well-rounded perspective on the topic. These findings helped to understand relationships in Catholic schools, the decision-making process, and stakeholder engagement. This chapter contains the following sections: restatement of purpose, research questions restated, research design, population and sample, sampling procedures, instrumentation, data collection procedures, data analysis, and limitations.

Open-ended questions were developed to capture interviewees' lived experiences. In this research, anonymity was an ethical concern, especially if a stakeholder was not engaged in the STEM initiative. It could have posed a challenge for the stakeholder should they not value the STEM direction and vision of the school. To address this, all names of interviewees, schools, and dioceses were withheld.

Research Question

The aim of this Dissertation in Practice study was to create a leadership model that Catholic elementary school principals will be able to adapt within their schools to engage stakeholders in leading STEM curriculum and instruction changes. According to Creswell and Creswell (2018), a research question in qualitative studies should include two forms: a central question and associated sub-questions. In accordance with Creswell and Creswell's (2018) model, the following research question guided this qualitative study: How do Catholic elementary school principals engage stakeholders in developing a STEM based program? From this central research question emerged additional sub-questions: what steps can be taken by Catholic school leaders to introduce STEM in Catholic schools? What are the teachers' perceptions and attitudes towards increase STEM curriculums in the classroom?

Research Design

I used the qualitative approach to examine how Catholic elementary school principals have engaged stakeholders through the development of a STEM program. I utilized a phenomenological study to evaluate the experiences of principals, teachers and staff, and stakeholders within the school community. This section includes the following: purposeful sampling of data, described the interview style, outlined the question template, and explained the data recording system. The qualitative data collection included the use of a STEM-focused, one-on-one stakeholder interview through a conference call. A one-on-one conference call interview gave me an opportunity to ask open-ended questions and record responses (Creswell & Creswell, 2018).

Participants/Data Sources and Recruitment

Participants in the study were 16 individuals involved in the development of STEM programs in four Catholic schools in the Diocese of Charleston (South Carolina), Archdiocese of Baltimore (Maryland), and Archdiocese of Newark (New Jersey). Each of the schools were identified as having completed STEM certification through Cognia or were in the process of moving towards certification. This information was collected through the National Catholic Educational Association (NCEA) and the Cognia database. Participants were selected from each of the identified Catholic schools. Principals from the four selected schools identified participants for the study. Principals recognized participants as those who were a part of the schools' STEM development and implementation. A total of three principals, one pastor, two STEM coordinators, and six teachers from all four schools were interviewed. An additional four stakeholders who held various roles on boards or councils in support of the four schools and who have been involved in the development of the STEM program at a Catholic elementary school were interviewed.

The four Catholic elementary schools had varying enrollment sizes. The schools served students in early childhood to middle school. Depending on the enrollment, the schools had one to three tracks for each grade. The selected principals and teachers held state administration or teaching credentials or were recognized by the Catholic Schools Office as having certain levels of professional development to qualify to lead or teach in a Catholic elementary school. All the schools had conducted professional staff development in STEM during the year. The four schools served children with various academic and faith backgrounds and learning needs.

NCEA and Cognia assisted with participant recruitment. These organizations were consulted as to which Catholic elementary schools located in the eastern region of the United States had successfully passed STEM certification through Cognia or would be going through the process. The NCEA had information pertaining to school location and size. It also provided essential information such as opening year, enrollment, grades serviced, and to which archdiocese/diocese it belonged. The diocesan superintendents and local ordinary granted permission for the study to take place, and contacts were made to the pastor or principal of the Catholic elementary schools.

Data Collection Tools

The main tool used for this study was personal interviews. Each interview consisted of thirteen open-ended questions, with follow-up questions. The interview questions can be found in the Appendix.

Interviews were conducted through conference calls. A device called REV was used to transcribe the interviews. Transcripts were analyzed on Dedoose. It also helped to identify major themes.

Data Collection Procedure

I developed an interview protocol based on standards and benchmarks established by the Cognia STEM Certification process and additional resources found through online STEM programs, such as S^2TEM Centers of South Carolina. A total of 13 open-ended interview questions were developed and submitted for review to the committee. After feedback was received, I edited the questions that were potentially leading or presumptuous. Questions focused on stakeholder engagement, STEM curriculum and programs, and the learning environment. The questions, along with the research question, aim of the study, problem statement, research methodology, and data collection, were then submitted to the Institutional Review Board (IRB) for a final review and approval. The process took approximately one month to complete. I received permission of archdiocesan/diocesan superintendents before contacting school principals. Once permission was received from the Catholic Schools Office, I contacted the schools' principals. I established interview times during the first semester with the pastor, the principal and school administrators, teachers, and other stakeholders such as parents, community members, and parishioners that assisted in the school's mission. I set up conference calls.

I interviewed those who had been most heavily involved in the Catholic schools' programming change based on the principal's recommendations. Those included parent or community stakeholders, administrators, and teachers, especially those who served on the internal STEM leadership team. The interviews were recorded and lasted approximately 45 minutes each. I used REV to transcribe the interviews and handwritten notes on a legal pad during the conversations.

Data Analysis

To complete the analysis of the data, I began to identify concepts that appeared in the transcripts (Babbie, 2017). I printed the transcripts and hand-coded the results using Dedoose. I highlighted key phrases or words that correlated in the interviews and noted major and unique topics onto a separate piece of paper (Creswell & Creswell, 2018). I identified relationships and arranged the topics into categories. Leftover topics were reviewed to see if they fit into a category (Creswell & Creswell, 2018). Category interrelationships were analyzed and matched accordingly (Creswell & Creswell, 2018).

A peer examiner reviewed the transcripts and data analysis for biases, discrepancies, and verification of identified themes.

I acknowledged that biases exist in the proposal and research due to my own development of a STEM program. I understood that STEM and components of it vary greatly from school to school. Depending on the school leadership as well as stakeholder commitment, STEM appeared different within the school environment. Some schools developed a STEM program that was specific to certain students and families. Other schools developed a STEM program that encompassed the entire school community and environment. I was aware in interviews and reviewing school data resources that not all schools have developed a STEM program in the same way or in the same direction.

Ethical Considerations

An ethical concern that stemmed from this study was anonymity. I recognized that principals might be concerned about speaking ill of their staffs or their pastors in addressing some of the challenges in introducing STEM to the school. I also recognized that teachers might be concerned about speaking against the school administration. The same was true of stakeholders, especially those who were close to the school and were a part of the process. If they served on a leadership team, the school board, or on committee, or may have offered financial support, they might have felt as though their words may affect the school’s standing in the community, especially if their opinion of the process differs from how it transpired within the school. Thus, it was important to protect the identity of the interviewees. When the final report was written, identities were withheld with names removed or changed.

Transcripts from the interviews were kept on Dedoose that was password protected. Any printed transcripts were kept in a locked desk drawer in my office. Scanned copies were moved to Google Docs which was password protected. Transcripts were retained in storage for at least one year.

Summary

The aim of this study was to create a leadership model that Catholic elementary school principals will be able to adapt within their schools to engage stakeholders in leading STEM curriculum and instruction changes. The study was guided by analyzing the research question of how Catholic elementary school principals engage stakeholders in developing a STEM based program. Thirteen open-ended questions were developed from that research question to aid in the collection of data.

A qualitative approach was used to examine the lived experiences. In this phenomenological study, I conducted interviews and analyzed pertinent literature and data to yield results that helped describe the process in which stakeholders were engaged in the development of a STEM program at four Catholic elementary school.

After IRB approved the proposal and archdiocesan/diocesan permissions were received, a study of Catholic elementary schools who were STEM certified or were in the process of becoming STEM certified through an accrediting organization, such as Cognia, took place. Connections were made with Catholic Schools Offices in the eastern region of the United States to seek permission from the superintendent, through the local ordinary, for the research to proceed. Principals of the schools were contacted to establish dates and times for interviews. Aside from interviewing the principal, I received further assistance from the principal to establish interviews with a pastor, teachers, and community and parish supporters. The interviews were the main tool for data collection and the recordings were created into transcripts. The transcripts, which were hand-coded and major themes discovered, presented a picture of how the Catholic elementary school developed a STEM program. Anonymity was the main ethical concern as some interviewees might have been concerned with speaking ill about their colleagues or the STEM initiative within their school. Identities were withheld in the final chapter.

CHAPTER FOUR: RESULTS AND FINDINGS

Introduction

Chapter four includes demographic profiles of the participants, an overview of the data analysis process, and descriptions of themes that emerged from the findings of this study. Themes that emerged, along with subthemes and evidence for each, are presented.

Purpose of the Study

Research has been conducted on various programs and strategies that have been effective in supporting STEM, there have been only a few specific studies examining the implementation of STEM programs in Catholic schools. The purpose of the study was to explore how Catholic school leaders engage stakeholders in developing and implementing a STEM program.

Research Question

The following research question guided this qualitative study: How do Catholic elementary school principals engage stakeholders in developing a STEM based program?

Aim of the Study

The aim of this study was to create a leadership model that Catholic elementary school principals will be able to adapt within their schools to engage stakeholders in leading STEM curriculum and instruction changes. Developing a STEM program in a Catholic elementary school could boost student interest in innovation and prepare students for future STEM careers. A by-product of a STEM program and environment within a Catholic elementary school may help to keep it competitive and relative in the field of education. For the purposes of this study, STREAM, which includes religion and arts within the acronym, was examined in the context of a K through 8 Catholic school setting.

Description and Rationale of Interview Participants

Three Catholic dioceses were selected for this research. One diocese was located in the southeastern United States while two were located in the Mid-Atlantic region. A total of four Catholic elementary schools were selected. Two of the Catholic elementary schools received Cognia STEM certification within the past two years. One school was in the process of becoming Cognia STEM certified. One school promoted a STEM program, but had not yet elected to pursue Cognia STEM certification.

I conducted a total of 16 interviews, that included three principals, one pastor, two STEM coordinators, six teachers, and four stakeholders. Participants were selected by the principal of the school and each had varying STEM experiences. Prior to the schools' development and implementation of a STEM program, some of the participants had not yet understood what STEM was or how it benefited the school or students. Each of the principals and STEM coordinators had specifically been trained in STEM or held professional development certificates or degrees in STEM. The pastor, teachers, and the stakeholders each had some previous STEM experience, but it was only when the school began the STEM focus that their familiarity with it grew.

In this study, there was only one male participant (the pastor). All other participants were female. The researcher compared the responses from the participants to identify common themes. Table 1 provides the profile of the participants of this study. To protect the identity of participants, pseudonyms were used.

Table 1

Summary of Study Participants (real names have been removed to protect their identity)

Participant	Gender	Current Position or Role	Years of Experience in Education	Arch/ Diocese	School Information
Fr. Jim	Male	Pastor	25+ Years	X	Suburban, PK-8, One Track of Each Grade, Approximately 250 students
Nancy	Female	Principal	15 to 20 Years	X	Suburban, PK-8, One Track of Each Grade, Approximately 250 students
Kathy	Female	Teacher	15 to 20 Years	X	Suburban, PK-8, One Track of Each Grade, Approximately 250 students
Emily	Female	Stakeholder	20 to 25 Years	X	Suburban, PK-8, One Track of Each Grade, Approximately 250 students
Mary Beth	Female	Stakeholder	10 to 15 Years	X	Suburban, PK-8, One Track of Each Grade, Approximately 250 students
Amanda	Female	Stakeholder	5 to 10 Years	X	Suburban, PK-8, One Track of Each Grade, Approximately 250 students
Patty	Female	Teacher	5 to 10 Years	X	Suburban, PK-8, One Track of Each Grade, Approximately 250 students
Kristy	Female	Stakeholder	5 to 10 Years	X	Suburban, PK-8, One Track of Each Grade, Approximately 250 students
Jennifer	Female	Teacher	5 to 10 Years	X	Suburban, PK-8, One Track of Each Grade, Approximately 250 students
Stephanie	Female	Principal	15 to 20 Years	Y	City, K-8, One Track of Each Grade, Approximately 150 students

Amy	Female	STEM Coordinator	5 to 10 Years	Y	City, K-8, One Track of Each Grade, Approximately 150 students
Kenna	Female	Teacher	10 to 15 Years	Y	Suburban, PK-8, Two Tracks of Each Grade, Approximately 500 students
Sandra	Female	Teacher	10 to 15 Years	Y	Suburban, PK-8, Two Tracks of Each Grade, Approximately 500 students
Savannah	Female	STEM Coordinator	10 to 15 Years	Y	Suburban, PK-8, Two Tracks of Each Grade, Approximately 500 students
Maureen	Female	Principal	10 to 15 Years	Z	City, K-8, One Track of Each Grade, Approximately 260 students
Roseann	Female	Teacher	15 to 20 Years	Z	City, K-8, One Track of Each Grade, Approximately 260 students

Summary of Study Participants

Presentation of the Findings

The following research question guided this qualitative study: How do Catholic elementary school principals engage stakeholders in developing a STEM based program? Data were gathered through interviews of participants who had experienced the development and implementation of a STEM program in a Catholic elementary school.

Eight themes emerged during the analysis of transcripts: (a) shared leadership, (b) professional development, (c) curriculum and instruction, (d) STEM program evaluation, (e) STEM culture, (f) enhanced interest in innovation, (g) strategic planning, and (h) the COVID effect. Figure 1 provides an outline of themes and subthemes that emerged from the data.

Figure 1

Themes and their related subthemes

Factors of STEM Development and Implementation Themes and Subthemes

Shared Leadership
- The Pastor and Principal Relationship
- A STEM Committee
    - Community Partners
- The Addition of a STEM Coordinator

Professional Development
- Retreats
- Teacher Feedback
- Professional Learning Communities (PLCs)

Curriculum and Instruction
- 21st Century Learning
- Differentiated Instruction
    - Cross Curricular Lessons and Activities
    - Thematic Units
- Problem Based Learning Experiences in the Classroom
- Engineering Design Process (EDP)
- Standards Based

STEM Program Evaluation

STEM Culture
- Makerspaces
- STEM Challenges
- STEM Fairs and Showcases
- Extracurricular Activities
- Collaboration and Service

Enhanced Interest in Innovation
- Intergenerational Experiences
- Building Student Confidence
- STEM Careers

Strategic Planning
- Sustaining STEM into the Future
- Financial Support

The COVID Effect
- Impact on Curriculum and Classroom

Theme One: Shared Leadership

The theme of school leadership played an important role in a school's ability to develop and implement a STEM program. The pastor's trust in the principal's capabilities, to forge a STEM path for their school, gave the stakeholders a sense of stability and togetherness. The pastor allowed for the principal to help bring about the vision of a STEM program to reality showed his commitment to the school and care for the students. A principal as the leader directed the STEM initiative. They found support in securing a STEM Coordinator, or teachers who served as STEM facilitators, to continue moving the vision forward and raising awareness about STEM in the school community. A STEM Coordinator assisted in analyzing curriculum, supporting teachers, and introducing new programs within the school day and after school. The theme of school leaders was important to develop and implement a STEM program and laid the foundations for the remaining themes that emerged in this research.

In interviews, participants expressed the importance of school leadership to develop and implement a STEM program. Participants indicated that a shared leadership approach was beneficial in leading STEM within their schools. The pastor, principals, STEM coordinators, STEM committee, teachers, and community stakeholders all took responsibility in leading the development and implementation of the STEM program in their Catholic elementary school. Participants also expressed how they supported each other in their role.

The leadership of the pastor and the principal was key when schools began the STEM initiative. In each of the principal interviews, the pastor was said to have been a key supporter and it was his leadership style that allowed those principals to pursue STEM on behalf of their schools. The pastor stated that he “trusted the principal to make the decisions that would best fit the school” (“Fr. Jim”). Fr. Jim said that he felt that the principal, who is a leader in curriculum, should be identifying what are best practices and implementing them in the school. He believed that his role was to support the best practices identified by the principal. Fr. Jim added:

> I like to share my vision for the school, but often my vision is more for the spiritual side of the school. I see my principal's role as helping to bring that vision to reality, as the spiritual leader of the school. But I also know that my principal has a vision for the academics and STEM was the right vision for our staff and students.

Pastor and Principal Leadership

Sandra, a teacher in the Archdiocese of Y, said that her pastor and her principal are the core of the school and "they have to be tight." Sandra affirmed that her principal's leadership helped others to "see the big picture" in developing and implementing a STEM program. Sandra said, "the principal's leadership style helps to bring stakeholders together for the common purpose and helps to advance the school's initiatives." Sandra felt that the pastor helped to rally support and helped establish connections for the school. "He might not have been fully involved in the day-to-day STEM initiative, but he definitely was a driving force and just his outward support for our school and STEM was significant for us" (Sandra).

Kenna, a teacher in the Diocese of X, said, "that partnership from the administration is a blessing and we are lucky to have that at our school." Kenna said "it was the excitement of the administration, which was the pastor and principal to start, that helped to drive STEM" in their school. She felt that most everyone was onboard because of how the administration team got them excited and helped to bring in community involvement to focus on STEM (Kenna).

Emily, who is a stakeholder in a Catholic school in the Diocese of X, believed that the creation of a leadership structure by the principal helped to move forward the STEM initiative. Emily said that it was Nancy, the school's principal, who helped to advance the STEM plan. She said:

> Nancy reached out to the community. She started with parents, because they were the low hanging fruit, but also reached out to the parish and then the larger community to rally support for the STEM program.

Emily felt that Nancy thought and worked outside of the box to get STEM started at their school. She said that "Nancy's outreach helped to bring new ideas into the school and made them consider different ways to do things" that were STEM related (Emily).

Kathy, who is a technology teacher in the Diocese of X, stated that her principal, Nancy, created a leadership team for STEM. She noted that Nancy brought people who had STEM expertise to the team. Kathy said, "it was Nancy's leadership ability to bring those who were comfortable with STEM and not comfortable with STEM together." Kathy said, "Nancy pulled together these human resources to bring ideas together on how to make STEM work for our teachers and students."

A STEM Committee

Participants in each of the four schools said having a STEM committee was an integral part in developing and implementing a STEM program. The principals of the four Catholic schools determined how their STEM committees were formed and who served on the committee. Committee members in all four schools were appointed by the principal and, in three of the four schools, the principal served as the STEM committee chair. In the fourth school, a STEM coordinator served as committee chair. The four school principals included: teachers, staff members, parents, and community partners on the STEM committee. Some committee members' previous STEM experiences included: STEM trainings, working in a STEM related field, or a specific degree related to STEM. Other members had no STEM experience. Having a broad range of STEM experiences appeared to help balance the committee in bringing about cultural change. STEM committee members who were inexperienced in STEM found that they were able to help convey the STEM message more clearly since they too struggled with how to implement STEM in the school or classroom. A STEM committee took time to grow, but once established, helped to define the school's STEM vision. Overall, participants found that the STEM committee was an asset to their STEM program development and implementation.

Stephanie, a principal in the Archdiocese of Y, noted that their school's STEM committee formed with teachers and parents. Stephanie added, "the archdiocese asked each school to take on a specific program." They selected STEM because it best helped address students' needs. Stephanie stated that STEM did not happen overnight. She said:

> It was a learning process for all of us, but the STEM committee helped to piece together our STEM vision and mission. I wanted to ensure that the right personnel were also in place at the school. Once the personnel were in place, I assembled the STEM committee and we began engaging in the plan. We developed a strategic plan emphasizing STEM from our committee. From there, our STEM committee built ideas on how to best implement STEM from that planning process. It really helped with collaboration across our school.

Nancy, a principal with the Diocese of X, built her STEM committee with only teachers to begin, but slowly added parents and community partners. Nancy described the process as follows:

> Having those who were skeptical of STEM or did not have significant STEM experiences were an integral piece on the STEM committee. The STEM committee, working with the outside STEM consultant, helped to lay the school's vision in STEM. It tied together the school's mission statement. The STEM committee was the driving force in determining the school's path towards STEM certification. I sent committee members to summer workshops to help their understanding of STEM, which was very useful for our planning.

Savannah, a STEM coordinator for a school in the Archdiocese of Y, was the chair of their STEM committee. She stated, "parents and community partners were added to the STEM committee along with teachers from the school." Savannah added that the STEM experiences of teachers, parents, and community partners were helpful in developing their school's STEM program. Savannah had connections to other schools, especially from public schools, and would learn about resources from colleagues regarding STEM and bring them back to the committee. "That is how the school began a robotics program. I was encouraged by a colleague in the public school system to come to an interest meeting and brought that back to our committee to discuss how we could start it at our school" (Savannah).

Being in a smaller school environment, Maureen, a principal in the Archdiocese of Z, said that all teachers were placed on a committee. "But teachers change committees yearly and the STEM committee has remained relatively consistent over the years"

(Maureen). Maureen felt that most teachers had been rotated onto the STEM committee for the past eight years. Maureen said that having Roseann on staff, and with her STEM experiences, "helped to move the committee forward" (Maureen). Maureen said that their committee has five to seven members on it, with the principal as the chairperson.

As a stakeholder, Kenna's perception was that the STEM committee formed organically, under the principal's leadership. "Our committee formed with two or three classroom teachers, two to three related arts/special area teachers including the technology teacher and librarian, the vice principal, and the marketing and communications director" (Kenna). In the same school, Kathy said, "the committee worked together to lay out the plan." "We used the Cognia standards and benchmarks for certification on our committee to develop our STEM goals." Kathy felt that the committee determined how STEM would best fit within the school.

Sandra, a teacher in the Archdiocese of Y, felt that the STEM committee helped to keep motivation towards STEM certification going in their school. "Our committee helped to address teacher concerns about STEM." Mentors from the committee were then assigned teachers who were struggling with STEM implementation. The school's STEM committee helped to strategize and organize the STEM program and addressed areas where the program could improve. The committee helped to drive the STEM certification process. Sandra sensed that "there was an overall feeling that the STEM committee was a voice for the teachers rather than imposing it from the top down." The STEM committee helped to provide a vision for STEM development and implementation through a collaborative effort, including with community partners. The STEM committee helped each of the four schools to determine the STEM vision.

Community Partners/Stakeholders. The participants found that community partners who were invited to participate in the STEM program development for the school helped raise more awareness about STEM. Community partners include parents, parishioners, and members of the community who may not have a strong tie or relationship with the Catholic school. Participants noted that relationships with community partners were developed over the years at each of the schools. From those relationships, there were short-term and long-term opportunities to collaborate.

Savanah, a STEM Coordinator in the Archdiocese of Y, said, “community partners helped to expand the STEM mindset and open up students to thinking about a STEM career.”

Kenna, a stakeholder, said, “community partners were invited more into the school rather than the school going out to into the field.” She said, “it was easier for one or two community partners to come into the school rather than taking a field trip with thirty or more students on a field trip” (Kenna). Kenna said that the school’s community partners included those from the technology field, automobile industry, and construction field. One of their major partners was the assisted living facility She described that experience as follows:

> That connection allowed for students and teachers to work closely with the facility and the facility with the school. It was a rewarding experience for our staff and students to have residents from the assisted living community be our community partners. We learned so much from them, including historical perspectives and learning about their past experiences. Our students also helped them with technology and learning all the new gadgets that were out there. This

> partnership is quite unique and certainly takes our students out of the traditional classroom and into some meaningful learning experiences.

Two participants mentioned that a community partner was the consultant from the outside STEM organization. As principal, Nancy said, "having our STEM consultant helped make connections for our teachers and drive home the importance of STEM." Nancy added that the STEM consultant helped to respond to questions from teachers regarding STEM.

A perception shared by a participant felt that parents within their Catholic school are invested in their child's education and are willing to take extra steps to help provide quality experiences for their child. Maureen, a principal, shared her experiences about community partners as follows:

> Our partnerships with outside organizations in STEM fields was a way to educate the students and teachers. A lot of those partnerships formed because our students' parents worked in that field or knew someone who did. We also reached out to parishioners through the bulletin about partnerships and a lot came through for us. Their STEM experiences or STEM job helped us with instruction and information and added topics around real-world issues and challenges. The partnerships correlated well with what we were doing in the classroom.

Community partners were an empowering piece to the school's STEM program. These were important relationships that helped bring additional support for STEM in the school.

Partnerships were created through relationships. Savannah's perception was that her previous experiences in other schools helped to engage her interest in STEM. It was being able to go back to those colleagues once she was named a STEM coordinator for information, support, and resources (Savannah).

Relationships with teachers and parents in the school community helped to share the school's STEM vision and allow others to join. Fr. Jim was asked to help find parishioners who could support the STEM program. Fr. Jim felt that he related to the parishioners and knew some of them well enough to know their career background and encouraged them to join the school's efforts.

One school engaged the local government and chamber of commerce as a part of their STEM goal. Establishing a relationship with mayor and town council led to them extending support and other connections (Mary Beth). The school joining the chamber of commerce was an opportunity to seek out new relationships to support the STEM program (Mary Beth).

The Addition of a STEM Coordinator

The position of STEM Coordinator was added to the administrative team in two schools. The STEM coordinator helped to promote STEM within and outside of the school community. They also supported teachers in the classroom and provided professional development for staff on STEM. The STEM Coordinator's responsibilities helped to promote STEM in the school and community and did so by means of the following activities:

- Mentored teachers on STEM
- Helped to find STEM workshops and professional development activities to support teacher knowledge
- Found available STEM resources to benefit the school's STEM program

- Helped to support teachers by discovering best STEM practices
- Researched archdiocesan/diocesan curriculum to evaluate how STEM would be incorporated into the lessons
- Supported adding extracurricular activities to shape the overall STEM program
- Provided a support service to the school staff and helped to bring STEM awareness

STEM Coordinators were seen as a leader within the school community because of their perceived value in helping to develop and implement a STEM program. Participants from two schools felt that a STEM program development and implementation would not be as successful in their schools without the leadership of the STEM Coordinator.

Stephanie, a principal, hired a STEM Coordinator when she came to her school. She noted that it was one of her first steps upon arrival at the school. Stephanie stated:

> When I hired the STEM Coordinator, it really helped because she spent time going through the curriculum and brainstorming ideas. Going through the diocesan curriculum takes time, time that teachers do not always have. So, her initial role when hired was to start laying out areas where STEM could be integrated, especially in our curriculum.

Stephanie felt that having a STEM Coordinator was one of the major personnel pieces that helped the school become STEM certified through Cognia.

In the two other schools, there were teachers who served in a similar role, but did not have the title recognition as STEM Coordinator. Those members of the staff had teaching responsibilities, but often had larger blocks of planning periods to focus on

STEM research, planning, and development. One principal referred to these teachers as STEM facilitators and they had a background in math, science, and technology. A principal, Maureen, said, "since we have a small staff, everyone is asked to take on additional roles. We have two teachers who are facilitators to help oversee our STEM program and help implement it." One of those facilitators had attended the University of Notre Dame's STEM program and brought that information back to the school to share.

Some participants noted that bringing STEM awareness to the school community was an important component to the STEM Coordinator's position. Participants responded that STEM awareness was acknowledging the importance of math, science, technology, and engineering and building it into the academic and spiritual program of the school. It focused on student innovation, creativity, and problem solving. Savannah, a STEM Coordinator for her school, felt STEM awareness was an important first step in their STEM process. She noted:

> As a STEM Coordinator, I had to help educate the rest of the community and that was a long process. That process lasted eight years and a lot of training, a lot of outside professional development, a lot of participating in different organizations and connecting with various groups to be able to bring that STEM mindset to our school.

STEM Coordinators found that their role was to provide educational support to the faculty and staff. Some participants responded that the research STEM Coordinators did on behalf of the teachers on incorporating STEM into the curriculum significantly helped them in their STEM unit planning. As a STEM Coordinator, Savannah saw her role as facilitator of STEM for lesson and unit design. "I developed shared folders in

Google so that plans could be shared and must reflect STEM integrated lessons." Savannah felt that she helped to facilitate STEM in the lessons so that teachers became more comfortable in STEM and how they teach it or bring it into the classroom. Similarly, Roseann, who handled academic and technology coaching for her school, said, "I meet with the teachers to see if they need any additional support, or I will look at the overall curriculum and see any connections and get different grades to work together." Roseann felt that much of what she does for the school is to help facilitate teachers collaborating to talk STEM and plan for STEM.

STEM Coordinators, according to some participants, were important to the school in developing extracurricular activities focused on STEM. Their ability to outreach to the community for support and to initiate clubs centered on innovation and problem solving were helpful for the teachers and provided a new opportunity for students. For extracurricular activities around STEM, Savannah noted the following:

> Our school had the first LEGO League in Robotics. It started out as a small after school activity, with the robotics club, but then it started to grow. We would go to competitions locally and then statewide. When we were first presented with the opportunity to join the LEGO League, I hesitated, but was encouraged by a colleague from another school. The commitment is incredible. We have had the LEGO League for the past six years. It has been amazing, and those kids present to the rest of the school and show off their projects.

Theme Two: Professional Development

Forming a system of support for teachers and stakeholders appears to have helped schools to develop and implement a STEM program in a Catholic elementary school.

Professional development opportunities, retreats and workshops, and established professional learning communities helped to raise STEM awareness and create STEM mindedness.

Participants overwhelmingly responded that professional development was impactful in the implementation and development of their schools' STEM program. Most respondents stated that they did not fully understand the concept of STEM until their principal brought in outside professional development opportunities for stakeholders. In some instances, participants felt that STEM was already incorporated into the school, but that it was not organized. When professional development activities increased around STEM, some respondents noted that additional time was needed in the schedule. One participant noted that purposeful and intentional STEM professional development was built into the school calendar so that it occurred at least once a month.

STEM workshops and professional development opportunities were viewed as useful in supporting teacher's knowledge and increasing STEM within the school's program. Participants explained that some of their professional development opportunities came by attending various workshops. Some examples of STEM professional development opportunities came from:

- Outside professional development opportunities for all levels of experienced and inexperienced teachers in STEM
- A STEM consulting firm
- Diocesan and school in-service days
- Staff retreats
- Professional Learning Communities (PLCs)

Finding outside professional development opportunities for all levels of experienced or inexperienced teachers in STEM proved significant in developing and implementing a STEM program. It helped to give direction for the STEM journey and proved for some participants that they were including STEM in their classrooms but did not realize it. Jennifer, a teacher, found that her colleagues, in one of their first professional development opportunities, acknowledged that they were including STEM in their classrooms. “We just did not know it. But there was no direct purpose or rhyme or reason to STEM.”

Bringing STEM professional development to the teachers may be dependent upon an outside consulting firm. Two Catholic elementary schools used an outside STEM consulting firm. Nancy, a principal, felt their partnership with an outside STEM consulting firm aided in their STEM awareness. She said, “we began our professional development with them on STEM over the summer because the teachers had more time to focus and they really helped to define our STEM’s purpose.” Nancy responded that the consulting firm provided their staff with direct support in STEM and helped to reach those teachers who were skeptical of STEM.

Other participants stated that their schools’ affiliation with an outside STEM consulting firm helped to pave the way for the development of the schools’ STEM program. “Amanda”, a parent, said”

> Our school first turned to the diocese for STEM support, but we were one of the first Catholic schools in the state to focus on STEM. So, they were not equipped yet to support us. We had to bring in an outside consulting firm to help bring STEM to our teachers.

Fr. Jim acknowledged that the STEM consultant was an important piece of professional development for the principal and staff. “I would meet with the STEM consultant sometimes just so that I could understand too what we were doing and how we were going to do it.” Fr. Jim felt that he wanted to support the administration and staff as well as be involved in the STEM process. He noted that the STEM consultant assisted in ensuring that the staff was collaborating on STEM.

All schools used professional development trainings to support their teachers in the STEM journey. Some of the participants reported going to professional development trainings locally and nationwide. Kenna, a teacher, said:

> We sent teachers to STEM trainings out of state—one workshop was held in New York while another workshop was in Seattle. But that is because STEM, at the time, was not big in our state or we just were not aware of any trainings on STEM happening in our region.

Kenna noted that later in their STEM journey, the school found a variety of professional development opportunities within the state and sent teachers to learn more about STEM instead of having to travel great distances.

Emily, a stakeholder, said she was aware that staff from her school participated in a weeklong STEM workshop out of state and a STEM workshop held by Cognia held regionally. “I know that they felt the STEM workshops helped the teachers know more about the process and how to incorporate it into the school.” Emily responded that the Cognia training was when the STEM leadership team learned of the STEM certification process and the STEM standards. “Using those STEM standards is how we started to build our STEM program at our school” (Emily).

Savannah, a STEM Coordinator, stated that their school partnered with Discovery Education Experience. She said, "it provided a variety of professional development opportunities for teachers, but also included professional resources that teachers could pull from to enhance their lessons to include STEM." Savannah further noted that the school partnered with two local universities for STEM trainings and support. She mentioned that those opportunities provided teachers with updated STEM resources and additional connections to where more STEM information could be found.

Patty, a teacher at the same school as Savannah, found that attending weekend trainings at a local university were beneficial to her STEM awareness. "The university provided workshops for us. We were looking to become more engaged in STEM and develop units and lesson plans around STEM learning" (Patty). She noted that the university allocated resources and templates on how to devise STEM plans.

Maureen, a principal, said that teachers who went to outside STEM professional development opportunities would return to school to share what they learned. "I would find them being offered or if a teacher came to me wanting to go to that workshop, we would get them signed up." Maureen responded that she would send teachers who were well versed in STEM and those who were new to STEM. She appreciated the diversity in how teachers viewed STEM. "A person who is familiar with STEM or a person who is not, the way that they would share with the staff would be very different, but very meaningful" (Maureen).

Participants mentioned time for professional development as needed in their STEM development. Setting aside quality time for professional development was important to the participants. However, there were eleven participants who said that teachers do not always have enough time for professional development. Those participants suggested that scheduling seemed to be the largest factor for the lack of professional development time. Participants also suggested that professional development offerings were not always consistent or were jammed into the allotted professional development days by the archdiocese/diocese.

Maureen determined that the most efficient way to dedicate this time for teachers and their STEM learning, as well as other professional development, was to mark every Friday in their school calendar as a half day. “It provided our teachers with two hours, every week, of collaboration and sharing. We would have topics around STEM and, right now, we are spending that time developing some cross curricular projects and instructional strategies in math.”

Nancy, a principal of a small Catholic school, felt that it was difficult to find more time in the traditional school schedule for professional development opportunities. Nancy stated:

> So, we did the best we could with the schedule and planning. But then we also set aside more funds in our substitute teacher budget and would bring in subs for the day. We would rotate the classroom teachers into a professional development opportunity that was being held within the school.

Retreats. Participants reported having staff retreats to help focus on STEM. These were working retreats, not spiritual retreats that are often associated with Catholic schools. It was reported that team building activities and brainstorming activities were two of the major components to the retreats. Retreats took place during the summer, and just before the new academic year. They were focused on STEM and engaged teachers in collaborating on lessons and units. A staff retreat laid the groundwork for the school year and focused on the community STEM goals.

Sandra, a teacher, stated, “our staff retreats were held annually in the summer and really gave us time to reflect on their previous year and focus on establishing the school year ahead. The retreats helped to center our professional self.”

Mary Beth, a stakeholder in a Catholic school, said “retreats reminded our teachers about their roles and responsibilities in the development of the school’s STEM program. I believe that the retreats really helped to establish the school’s goal of becoming STEM certified.” Maryanne reported that STEM goals were established for the year at retreat, with STEM certification being the main objective. From the retreat, she noted that the teachers then planned their professional learning communities work and learned how to support each other during the school year in STEM. “The teachers basically planned the academic year focusing on STEM in the retreat.”

Teacher Feedback. Most participants noted teacher feedback was important in the development and implementation of a STEM program. It provided information to the STEM leadership team, especially the principal. In all cases, the principals or STEM Coordinators initiated surveys, verbal or written feedback, or individual or group sharing opportunities throughout the STEM journey, especially for professional development and workshop experiences. The surveys were done mainly through SurveyMonkey or Google Forms and were short but provided important feedback to the principal. Pulling information from surveys and teacher forms helped set the professional development opportunities in STEM for the school year and tie together the STEM goals. Feedback from the forms or surveys helped to plan for the next teacher workshop on STEM.

Surveys yielded main focal points about the STEM professional development opportunities teachers were receiving. Some participants noted that surveys were used prior to the start of the school year so that it would help plan for STEM related activities and STEM schedules. One participant noted that their school begins the academic year by surveying the teachers about professional development opportunities that would interest them. Some participants said that the Professional Learning Communities (PLCs) were a way to share feedback verbally and led to more fruitful discussions surrounding STEM and STEM practices.

Nancy, who serves as a principal, appreciated having teacher feedback. She said:

> Feedback is important for me to know the teachers' reactions to the STEM workshops and to make sure that they were worth everyone's time. We take many, many teacher surveys throughout the year and they are about the professional development activities we have planned. I share the results with the teachers either in a teacher meeting or maybe when we are in our PLCs. That feedback helps me to know if we are on the right track for STEM or do we need to do something different to make our professional development time better.

Nancy used the diocesan professional development and goals form required of each teacher to evaluate individual teacher STEM goals. She also used the form to address STEM professional development opportunities for staff. "It helps me to know where they are and where they want to go, professionally" (Nancy). Nancy developed the professional development calendar based on the diocesan form. Nancy said, "our journey towards STEM certification is because so many teachers had put STEM as a focus for them."

Kenna, a teacher in Nancy's school, said "there are a lot of surveys that go out to the staff after professional development workshops." She further stated that the staff appreciated Nancy sharing results of the survey at staff meetings or the PLCs. "It helps us to know what everyone is thinking. The surveys help to know what is working and what is not working." The staff started planning for the next STEM workshop based on that information.

Since Nancy's school utilized a consultant in their STEM program development and implementation process, the surveys provided the consultants with immediate feedback as to how to alter their next workshop with the staff. Jennifer, a teacher, said, "we would give that feedback to our consultant, and she would kind of plan ahead how to fix it so it met our needs or addressed our issues." Jennifer also said it was important for them to stay focused on one or two pieces of information in the STEM workshop because the staff would get overwhelmed. She said:

> We also would target specific things in STEM that we wanted to know when planning for a workshop with our consultant. Once we narrowed those down, what the content we were looking for, Nancy would communicate with the consultant to build the next workshop around those pieces.

Opportunities to share verbally in meetings or PLCs were instrumental in the overall STEM development and implementation. One school moved past more formal surveys and found group sharing more useful. Sandra reported:

> We were more comfortable sharing with each other in either whole group or small group. That really helped to build our teacher collaboration in the school. I think teachers also took on a leadership role by doing that. It gave us a voice. It let us be

> more vocal about which professional development opportunities in STEM that we felt that we needed. Not just handed down to us from the principal. We also felt like we started to see our own strengths and weaknesses in STEM. And that helped to plan our next workshops because we knew what areas we were struggling with and needed extra support in STEM.

Savannah, who is a STEM coordinator, felt that teachers were comfortable in sharing their professional opinion. She felt that it showed growth among the teachers and their professionalism. Savannah noted that she found teachers would not hesitate to let her know when a STEM workshop was not worthwhile. However, they shared their excitement when there were workshops that were valuable. “Teachers would ask me for the trainer’s contact information if they really enjoyed the professional development opportunity and we were always grateful for trainer’s who did not mind us reaching out to them after the workshop for follow up questions.”

Professional Learning Communities. Participants reported that PLCs are an important piece in teacher development in STEM and developing and implementing the school’s STEM program. In the Catholic elementary schools selected for this research, each similarly developed their PLCs based on grade bands. Pre-Kindergarten to second grade, third to fifth grade, and six to eighth grade were the core PLCs while related arts or special area teachers were interwoven into the grade bands or rotated between the core grade bands. PLCs paired teachers together giving them an opportunity to work with colleagues they may otherwise not. Some participants noted that planning in PLCs helped to bring teachers and stakeholders together.

Amy, a STEM coordinator, reported that PLCs allowed teachers to work closely together on addressing the school's STEM goals. "Our teachers and staff had great discussions on what was happening in the classrooms that were STEM related and then they would align those to the STEM goals that our committee had established" (Amy).

As principal, Nancy found PLCs provided teachers with opportunities to learn from each other. She said:

> Teachers were more comfortable in teaching each other lessons learned about STEM. We found that teachers were teaching their own team, and then teachers were putting that into the STEM curriculum, and then the teams were teaching the parents and other stakeholders. I found that more reluctant teachers who were skeptical of STEM grew in their PLCs. They made better connections with their colleagues who could help to explain STEM, how STEM could be brought in the classroom, and raise their level of STEM understanding.

One respondent noted that PLCs would gather as a whole staff during the month for sharing of ideas and to enhance STEM collaboration. Kenna reported:

> If a STEM idea was shared in one grade band, other grade bands would hear about it and then they started working on how to bring that STEM idea to their students and on their learning levels. In PLCs, teachers also found that their own professional curiosity was growing in STEM, because it was starting to appear everywhere.

Kenna witnessed how other staff members professional and personal interests in STEM were growing. Kenna's perception was that teachers in PLCs spent more time researching STEM ideas and how to implement them in their grade bands or within their classroom.

Sandra, a teacher, discussed how teachers in a core class may collaborate with a related arts/special area teacher to plan a STEM project. She said, "witnessing the social studies teacher and the physical education teacher planning a STEM lesson together through the PLC was unique! Before we started STEM at our school, this type of planning was not normal."

As a teacher, Jennifer's perception was that teachers began strategizing more efficiently in their PLCs. Jennifer said:

> The STEM leadership team was very important, but I think that the PLCs were the next biggest component in getting the STEM program developed and implemented at our school. The PLCs were where we could take ideas and really work on them and make them our own.

Patty, a teacher, affirmed that their school's PLCs put teachers who did not normally see each other together. They would work together on STEM lessons and plan together. The PLCs helped to move the school's STEM goals forward. Patty reported:

> We also had the PLCs set up so that teachers could sit in each other's classrooms to observe STEM lessons. Those observations are powerful. Teachers would come back together in their PLCs after observations were done and debrief. They would talk about alternatives, new ideas, and strengths in the lesson. It was not the standard principal-teacher formal observation. It was teachers observing each other and offering advice and support.

Theme Three: Curriculum and Instruction

Participants were asked about the purpose of implementing a STEM program. Some participants noted that they were preparing students for STEM careers. Other participants stated that they were developing the 21st century learner. Participants felt that they needed to better prepare students to handle challenges through problem-based learning. Participants also reported that students had diverse learning needs that they felt STEM could address. Their responses pointed to an overall change in the way that curriculum and instruction were delivered.

The 21st Century Learning. Participants were asked what the purpose was in developing and implementing a STEM program. Responses focused on developing a diverse learner who is prepared for the 21st century.

Sandra, a teacher, said:

> We must be able to reach these students, these 21st century learners. Teachers have to be prepared, even if they are kicking and screaming, need to be ready and we found the best approach to reach the students is through STEM.

Sandra noted that students are diverse learners who approach their learning differently.

Nancy, a principal, said:

> The basics and fundamentals of education are important. But we want to be able to have our students apply those things that they learned so that they can really own their education. Long gone are the days of students sitting and listening to a teacher. They need to get into the experience and really work with their hands and their minds. They need to explore. We want more hands-on learning, and problem-solving students who can handle almost any situation. When I think of a 21st century learner, I think of someone who has all the available tools in their possession, and they are ready to tackle the challenge.

Differentiation Instruction. A STEM program is developed and implemented with differentiated instruction and material embedded. Some participants referenced thinking-outside-of-the-box when discussing student learning experiences. A STEM program appears to also be an inclusive program.

Nancy's perception was that STEM existed within the school with the amount of differentiated instruction the teachers were already incorporating in the classroom. "When we started doing more STEM challenges and getting STEM more in the classrooms, the differentiated instruction naturally aligned with the planned units the teacher had set up." Nancy referenced the thinking-outside-of-the-box as the STEM spectrum. She said that they "aim to develop students who can solve problems and do so on their level." Nancy noted that students learn on different levels, so the teachers aim to instruct on different levels. "STEM helps us to differentiate our instruction at our school." Students' abilities to design and create vary from age group to age group, but also based on experiences and maturation. A STEM program offers students a different way to learn and "an opportunity for all of them to be successful" on their learning level. "Students learn with the support of their teachers and other students how to tackle a challenge. Some students have more scaffolding than others" (Nancy).

Emily, a stakeholder, felt that a STEM program was more inclusive. "It was inclusive because parts of the school's program became more differentiated through STEM. Our drama productions were really student done instead of us buying a readymade drama program."

Another stakeholder, Kristy, reported that students became better writers. She said:

> Because students were having to explain their conclusions in writing. Their writing was on their level, but it greatly improved across the board, and you were seeing writing in all classes, like in math and art class, where you typically do not see writing taking place.

Kristy noted that various core and related arts courses enhanced students' abilities to design and build. "I also feel like some students who struggled with the traditional test would really shine in STEM related projects where they had a chance to showcase their talents in a different way."

Cross Curricular Lessons and Activities. Cross curricular activities appeared to improve student learning connections. Cross curricular lessons and activities intermingled students in the same grade-band or grade level and focused on similar content or themes.

Kenna, a teacher, reported that their school intermingled students within the same grade range. She said:

> The staff felt that students were grappling with the material with more depth in those grade ranges. Our observations led us to believe that these cross curricular activities allowed students to see the information in a different way than with their regular classmates. With the school being one track per grade, having cross curricular activities within grade ranges helped with the sharing of ideas, and there are different skills and ways of thinking that are involved in this process. Our grade ranges were Kindergarten to 2nd grade, 3rd to 5th grade, and then 6th to 8th grade.

Kenna addressed cross curricular activities that involved teachers planning together. "We collaborate so that the same ideas or topics are being covered from classroom to classroom." Kenna reported that teachers brought their lesson plans to staff meetings or PLCs, review the standards, and then make note of when plans matched. She added:

> We had teachers who might teach math, but could see where they could bring in religion, and science, and writing into their lessons. When students, who studied ancient Rome or Greece in social studies class, built aqueducts in science class, the students saw their learning pulled together.

As a teacher, Sandra believed that being in the same room with her colleagues and organizing the cross curricular activities was an important step in their STEM certification process, but also in improving their academic program. "In my observation, students were also making better connections to their learning."

STEM Coordinator, Savannah, said that their school started out small in planning cross curricular activities. Savannah stated:

> It was a requirement to build a collaborative lesson with one other teacher in the school. After doing that for about five years, it became commonplace. And then we expanded to plan with more than one other teacher. Planning cross curricular activities also introduced students to new ways of being evaluated and assessed on their knowledge. It is great to see students reacting in such a different way. You know we have all these traditional tests and quizzes, but their interaction with a culminating project that encompasses different subject areas is exciting.

Thematic Units. School-wide themes provided some teachers with the foundational piece to develop their units and lessons around STEM. In one school, teachers developed the school-wide theme for the quarter. In another school, by choosing a theme per quarter, one participant felt it allowed their teachers and students to delve further into the content.

Stephanie, a principal, said, “teachers would develop thematic units for the semester or quarter.” They found that engaging the teachers and students in the theme was important for STEM implementation. “The themes gave us something to focus on. A topic or content we could know and see and understand. Two examples were the Chesapeake Bay, because we are so close to the water, and the other one we did was on the monarch butterflies.” Stephanie noted that everything the staff and students completed in that semester was related to the bay or the butterflies. “So, math lessons were around it, so were social studies lessons, and art class.”

As principal, Nancy said that her teachers found that working in quarters provided more current and relevant topics for teachers and students. “We decided as a team that doing a school-wide theme did not work well for us. It became too overwhelming. We wanted something that was more manageable for us to do in a quarter.” Nancy noted that she wanted the teachers to have ownership of the theme. From that theme, the staff planned out extracurricular activities for the year or academic programs during the school day. Nancy reported that was how the staff selected the first quarter theme of Dia de los Muertos, or Day of the Dead, last school year. “Our Hispanic community is growing in our church, but our staff and students in the school did not understand the holiday.” It gave their school community an opportunity to understand it culturally and to find the similarities and differences in the Catholic Church in the United States and in Mexico.

Emily, a stakeholder in the school community, felt that focusing on the Day of the Dead was not just about the holiday. “Students spent time studying all aspects of life—from birth to death.” Emily reported that she appreciated having her own children visit those who were in the nursing home. They understood the term geriatric. Emily said, “the children learned about diseases, like Alzheimer’s, and I think they appreciated the elderly, especially when listening to them tell stories. The students would come back after these field trips to the nursing home and write down their observations.” Emily reported that using that theme of Day of the Dead helped to make better connections and deeper understandings for the children. It tied together with culminating activities that were age appropriate, such as in art class where the theme was incorporated for Dia de los Muertos. “My 5th grade son made clay animals, similar to the ones you saw in the movie *Coco*, and other grades made papier-mache costumes and held a parade in the school right around the holiday” (Emily).

Problem-Based Learning Experiences in the Classroom. Problem-based learning (PBL) aligned in the development and implementation of a STEM program because it provided students with problem solving skills. PBL engages students and authentic learning experiences provide better connections for students in their learning process. If they are hands-on experiences, participants found students were also more engaged in the material. A participant also noted that a STEM program helps to bring together teachers and their approaches to teaching.

Maureen, a principal, said, “problem solving was traditionally taught in our school, but we realized that students were not problem solving on their own. Teachers wanted to solve it for students.” Maureen said that the problems that are presented to the students are authentic. “It develops their problem-solving skills. It helps the student reach their highest potential, and their high-level thinking skills according to Bloom’s Taxonomy.”

Roseann, a teacher, reported that “a STEM program provides students an opportunity to understand the problem. After they understand the problem, then students begin to solve it, create and design, and improve on that design before presenting their final product.” With problem-based learning, Roseann found students were taking more ownership of their learning.

As a STEM coordinator, Savannah reported that the robotics program that was implemented in their school helped to solve real world problems. “Students were exposed to a new way of thinking about an issue. They had to talk to the robot experts who helped facilitate our program. Students had to get a better understanding what was the problem and start to break down why it needed to be addressed” (Savannah).

Jennifer, who teaches in the Diocese of X, believed that PBL helps students to dive deeper into the issue. She said:

> The situation becomes real, and I think students have greater connections to the learning experience. I found that students were more engaged in real-world problems, and they wanted to solve it. We moved away from teachers providing the problem and telling students how to solve it and students memorizing that.

Sandra, a teacher, noted that just as students learn differently, teachers teach differently. She noted:

> I noticed other colleagues pulling in material that they have a passion about. They turned these passions into projects in the classrooms and PBL experiences for the

> students. We discovered that if the teacher really enjoys the material and wants to learn along with the student, creating these real-world problems to solve changes the dynamics of the classroom.

Kathy, a teacher, reported that teachers must note that there are no right ways and wrong ways to solve a problem in a STEM program. "There are multiple ways to solve a problem. Everybody thinks differently and everybody has different skills and working together to solve the problem is very important."

The Engineering Design Process (EDP). Participants reported that the Engineering Design Process (EDP) generally included five to seven steps, depending on the level of education. Most participants focused on five steps in their schools which included ask/research, imagine, plan, create/design, and improve, while also sharing and collaborating were involved in most steps. Some participants reported that the EDP is a major piece in the STEM process.

As a stakeholder, Kristy said:

> The EDP was one of the first items that our school focused on when beginning the STEM path nearly six years ago. The EDP helped us to take a step back, even in how we planned our units, to make sure that most, if not all, the steps were included in our lessons.

Kristy reported that posters were printed and placed around the building and in the classrooms as visual reminders to the staff and students about the EDP. Kristy also shared that their school would share stories of inventors and their failed ideas as a way for students to understand that it is challenging to fail, but there are ways in which to learn from that failure and improve upon it. She said:

> Our principal always tells students that, if it were not for people who work on televisions and improving upon them, we would still be watching black and white shows and trying to mount a console television set to the wall instead of these high definition, crystal clear, flat televisions with all sorts of internet capabilities.

Another stakeholder, Mary Beth, said, "the EDP reminded students to continue to improve. I know that some students want to rush through a project or a paper and think it is perfect. Knowing the teachers would ask the students to go back and improve upon their product was difficult at first. Students were upset, but over time, that step of improving became a part of the regular classroom experience."

Kathy, a teacher, said that their EDP became a part of their school's motto, *B.R.A.V.E. B.R.A.V.E.* is an acronym for bold, respectful, altruistic, virtuous, and excellent. The school blended the steps of EDP and their motto. Kathy said:

> For example, being bold means to be strong, but it also means for our students to not be discouraged. That ties right into the creating and improving steps, because we can see students get easily discouraged if their first designs do not work like they had imagined. That helped them to read more about what STEM was all about. Our EDP flowed from our motto to our classrooms. The EDP is incorporated in our English-Language Arts classes. Students are writing down their ideas, explaining their ideas in writing, formulating their ideas on paper, restructuring it, coming back to the table if it worked or did not work, writing up a final copy. Students are asked to keep detailed notes on their designs.

Jennifer, a teacher in the Diocese of X, noted that the school staff initially thought the EDP focused more on technology or sciences. Jennifer reported the following:

> Our school spent a lot of time going over the EDP process and that it belongs in all of subject areas. It was even incorporated in their school's music classes. Students were given the challenge of creating musical instruments, either through crafting and building or creating music electronically through a program on their laptops.

Standards Based. Developing and implementing a STEM program is rooted in curriculum standards. In some instances, participants responded that Catholic elementary schools moved beyond the diocesan or state standards by including standards and benchmarks from other organizations because they aligned with STEM curriculum. One school moved beyond the recommended diocesan standards in science because the Next Generation Science Standards (NGSS) integrated components of math, English-Language Arts, technology, and engineering. Another school completely utilized the state standards because they incorporated STEM within them and helped to guide instruction and define the behaviors of STEM.

As principal, Maureen said:

> Our STREAM program has, of course, religion as a part of the program. But we base it on the UN Sustainable Development Goals because these goals are civic based and help address problems in our own community. Our students research the goals and determine which one or ones they want to work on during the school year.

Maureen noted that the UN Sustainable Development Goals addressed problems in the world, but also those that exist within the school community. "Students are learning their faith, but also putting their faith into action by helping others through these UN goals."

Kristy, a stakeholder, noted, that their school used the NGSS because they were teacher friendly and:

> The standards have the information our teachers need to know to develop their STEM lessons. I think these standards were more in line with our school's focus on the sciences. It really helped us to move beyond the basic science standards.

Kristy said that there was more consistency across the board for both teachers and students by incorporating NGSS into the school's academic program.

Savannah, STEM coordinator, found that their state had STEM already built in their standards. By adopting them, they helped the staff to identify the learning behaviors of STEM and helped to guide instruction. "That was a big step because then we started to partner with private and public schools and local colleges to share STEM material based on those standards." Savannah reported that the school and teachers benefited in these partnerships because they were able to secure materials and resources from those institutions that they could use immediately in the classrooms. Savannah said:

> Our school announced the standards the teachers would be following on our website and in a newsletter. We wanted parents and our school community to know what we were doing in STEM and the partnerships that we had made. We were proud of our connections in STEM with those colleges.

Theme Four: STEM Program Evaluation

Participants noted that stakeholder feedback on the STEM program through the initial development and ongoing implementation was important. Feedback from stakeholders help to determine what parts of the STEM program need to be addressed and respond to concerns about its development or implementation. Feedback from other stakeholders, such as parents, parishioners, and community members, was significant because their support and feedback contributed to the overall makeup of the STEM program. Additionally, feedback from students is an important step in STEM development and implementation. The evaluation process appeared to give students more of an ownership in their learning experiences and stakeholders a voice in the school's STEM development and implementation.

When developing and implementing a STEM program, participants reported that program evaluation from outside of the school community provided important information on the STEM program's strengths and weaknesses. Bringing in outside feedback, those who are somewhat unfamiliar with the school, can bring a new perspective that teachers, principals, and students appreciate. Participants felt it provided to the faculty and staff an outside perspective on their STEM program. Receiving feedback from stakeholders also helped to bring new ideas to the STEM program and for the teachers to feel supported in their STEM efforts.

When the STEM program began its implementation phase, Jennifer's perception was that feedback through surveys was just as important than when the STEM program was in its development phase. Jennifer, a teacher said, "it gave us information on how it was being received by the students and teachers. We wanted to include the stakeholders in the community. We wanted to know what changes were needed." Jennifer said that they used the Cognia surveys to help elicit feedback from stakeholders. "It helped us to be able to address any STEM concerns that parents had about our program."

An important step taken at Nancy's school sought feedback from students. Nancy said, "our school wanted that feedback from the students about the STEM curriculum.

We usually used the Cognia surveys for this information that is then shared with teachers." Nancy said she valued the students' input and feedback. "I thought it had a big impact on the students and what they were learning by hearing from them. I think there were stronger connections happening in our school with student feedback." In seeking feedback from the community, Nancy said that the school included a question in the annual survey asking about the parent's career, or if they knew someone in a STEM field, and if they would volunteer to speak to students. Nancy noted:

> The school had a lot of response to that question. And these folks were willing to support the school either with their ideas and information or who were willing to visit classrooms to really bring together a nice learning opportunity.

Kristy, a stakeholder at a school, said, "student feedback can be a challenge because you first have to change the mindset of teachers." She noted that teachers are accustomed to having a principal or supervisor observing them and offering feedback, but to have a student or students offer feedback through a survey about their learning experience is something new, "but should be done regularly and often."

Sandra's perception was that the students have an opinion about what they want to learn, and teachers knowing that helps their unit and lesson planning. "It is not that teachers are ignoring the standards or the goals of the school, but they are taking student interests and aligning them with the themes or the content being taught."

Patty, a teacher, perceived parents with a STEM career were more inclined to volunteer their time to speak as an expert to the students using surveys and seeking feedback. She said:

> That was a great connection for our teachers to meet people in the community who had a job that related to something that they were teaching in the classroom. And, of course, it was huge for our students too. That all came from getting feedback on our program and how people could help our program move further along.

Maureen, a principal, responded that their school held roundtable discussions to receive feedback on their STEM program. “We selected people from the community who would share their concerns and ideas to a group of teachers about the school’s STEM program.” Maureen reflected that they often brought outside experts in a particular field to evaluate student projects and offer feedback. She said field experts from a particular STEM career are invited to evaluate student projects. “It is much like your annual science fair, but we do it more consistently and it gives students feedback from someone other than their teacher. Their opinions were not biased.” Maureen said the outside experts help support students as they plan and create their projects leading up to the annual STEM competition.

Jennifer said that their outside STEM consultant, through observing classrooms throughout the year, offered teachers an outsider’s perspective and an outside voice in the evaluation process. She noted that the STEM consultant offered an unbiased opinion and had built up trust over time with the teachers. Jennifer said that the teachers valued the consultant’s opinion and feedback.

Theme Five: STEM Culture

As STEM was introduced to the school community, the STEM culture grows. It was a shift in the mindset for students, teachers, parents, and other stakeholders.

Participants reported that creating a STEM culture requires shifting mindsets from traditional forms of education to STEM education. Though various forms of traditional education still exist within the learning environment, participants noted the school community goes through a transformation where educators allow students to take more ownership in their learning; teachers introduce instructional practices centered on STEM; that failure is an option but to understand why; relationships and connections help to build the STEM program; and financial support helps to advance STEM implementation. Participants reported using various strategies such as implementing makerspaces and STEM challenges to infuse the culture within the school.

Participants also mentioned the lack of available space and scheduling conflicts as challenges to introducing STEM to their community. Though this change takes time, it is the steps taken, such as collaboration, that helped the teachers become more STEM aware and more comfortable in their STEM approach. Introducing STEM challenges, the Engineering Design Process, and makerspaces helped to lay the foundation for the STEM program. New extracurricular activities, within and outside of the school day, appeared to increase and provide opportunities for students to enhance their learning.

Makerspaces. Makerspaces were communal areas that allow individuals or groups to explore, create, and design. They offer tools and resources for designing a project. Makerspaces included spaces available within a school such as the library, a lab or art room, the auditorium, and even hallways.

Some participants pointed to creating a makerspace within the school that encouraged STEM activities and STEM mindedness. Participants reported the makerspace gives students an opportunity to imagine and create. Some participants mentioned having makerspaces within the classrooms or a designated makerspace within the building.

Nancy said that they added STEM literature to the school library that provided students with various challenges. “We gave students an opportunity to read through some STEM challenge books. They had great ideas in that material. And then we had boxes of supplies and materials that they could pull out and go to work on creating.”

Maureen, a principal, felt that their building, because of its age, had difficulty physically adding a makerspace or STEM lab. “However, we use every nook and cranny of the school because we have a very limited building, but it does not limit the possibilities for us of what we can do.” Maureen noted that the teachers used the auditorium if they needed a larger space to work with students, moved tables and desks around to create more of a lab environment instead of a classroom set up, and worked in the hallway with small groups of students on STEM activities.

Kenna, a teacher, said her school converted a portion of the Art room into a makerspace area. Kenna said:

> I took trash and junk and turned the Art room into a makerspace. I even would use some of the time students were in the Art room for Art class to create with the materials that we had collected. I sometimes let the students’ imagination just run wild. And I loved hearing their explanations on what thing or contraption they made.

Savannah, a STEM coordinator, noted that students had opportunities to rotate through the makerspace area. “It helps them become more excited about their learning and they are exploring instead of being told what to do.”

As a stakeholder, Kristy said that their school had makerspaces in most, if not all, the classrooms for students to think and design. "Our school added Genius Hour into the schedule with some planned and some unplanned opportunities for students to create. It helps to break up the day and gives students a chance to think."

STEM Challenges. Participants noted STEM challenges to introduce STEM to the students and staff. They felt that the more comfortable teachers were with STEM challenges, the easier it was for them to be integrated into the classroom experience.

Kathy, a teacher, reported that some staff were hesitant with STEM because they are unsure of where to begin. "Our outside STEM consultants helped to create STEM challenge bags for teachers so we could understand what the students were going to have to do." She said the teachers discovered that the challenges were not for play or were time-consuming, but tied together standards, instruction, and curriculum. "Our STEM challenges really grew to where they were almost an everyday occurrence. So, they were a part of the regular classroom instruction rather than something separate. We definitely got more comfortable with STEM challenges over time."

Nancy, a principal, reported that STEM challenges took time to become more fully integrated into the school, but provided a foundation for teachers to understand STEM. Nancy reported that:

> We moved from seeing STEM challenges about once a month to twice a month and then once a week and now it is integrated daily. Then it moves from being a separate piece in the lesson to a component within the lesson that is evaluated and assessed, the same as classwork, tests, and quizzes.

STEM Fairs and Showcases. Participants noted that opportunities for students to showcase their STEM projects through STEM nights, STEM fairs, or STEM showcases were important steps for school's developing and implementing their program. They noted how it helped for STEM growth in their school and community. Some participants said that the opportunities to participate in STEM festivals helped to raise the level of interest in teachers and students.

Savannah, STEM coordinator, felt that the school's participation in the state's annual STEM festival was a big step for their teachers and students. Savannah stated:

> Our school being invited put us on the same playing field as other schools, especially public schools, who had established STEM programs. We started small. We had maybe one or two teams go to the festival first. And then we kept adding teams year after year and different grade levels. When we started taking home some awards, we got noticed and our community was proud. We knew we could compete with any other STEM school.

Mary Beth, as a stakeholder in her school community, noted that a school hosting a STEM night or a STEM showcase was an opportunity for stakeholders to view the work students had completed or were working towards completion. "We all know that a lot of schools host a science fair, but that usually takes place once a year. STEM nights were at least four or more times a year and were tied to the unit theme or the school-wide theme."

Patty's perception, as a teacher, was that parents were more inclined to participate in a school club or volunteer for a STEM activity once they attended a STEM night at their school. "We soon had parents helping out because, one, they could see what STEM meant in our school and, two, they felt comfortable in lending their expertise and support for the group."

Maureen, a principal, said that their diocese held its own STEM festival where Catholic schools are invited to participate. "It is open to the public and there are usually a lot of people who come just to check out student projects." She said it has led to the school earning recognition and establishing new connections with other Catholic schools. "We found that we were starting to partner with other Catholic schools and teachers on STEM projects. And teachers were sharing STEM ideas."

Extracurricular Activities. Two schools found that the increase of extracurricular activities aided in their STEM focus. One of those schools had begun the year with a staff survey that sought teacher interests. Then the schedule was built so that those extracurricular activities are not held after school, but within the school day. Participants reported that extracurricular activities extended the learning process for students within and after the school day. They provided students with furthering their depth of knowledge through these experiences.

Jennifer, a teacher, said, "our after-school activities or clubs formed out of teacher interest, in some cases. I had an interest in learning too and I thought what better way to do so then with the students who also had an interest."

Nancy, a principal, said, "we began setting up clubs in the regular school schedule. They were set up for the last period of the day at least once a week." Some examples she gave were foreign languages not typically offered in the regular school program, genetics and family tree research, knitting and sewing, coding, and Bible studies. "We change year to year and based on teacher interest. But it really opens up a whole new level of exploration for the students and gets them into something that really interests them."

Another participant, Savannah, said, "our school starting down the STEM road helped to determine our offered activities because it was based on genuine student interest." She noted that it began with a speaker series at the school during the school year. It grew and became more organized, with it extending beyond the classroom. Savannah reported that the school's LEGO Robotics Club was started at their school through the speaker series. "It started off small, but it grew over time, and we would take students to more local, state, and nationwide competitions." Savannah also reported the school also started a Cyber-STEM program that included coding and programming. It introduced students to STEM careers and chronology. Savannah felt that participating in the clubs opened opportunities for service. "Students created assistive devices for animals that were injured. Using the 3D printer, students made prosthetics for cats, dogs, turtles, and other animals."

Sandra, a teacher, organized the school's environmental club because of the school's proximity to a major waterway. Sandra reported:

> It was a major interest for students and the greater community because that bay is a part of our life and for a lot of our parents, their livelihood. Students wanted to know more about it and the lifeforms in it and how to protect the bay. We had many community experts helping us with that club.

Collaboration and Service. Participants noted, especially Sandra, that collaboration became more meaningful and purposeful in the development and implementation of a STEM program. As teachers planned units and lessons together, Sandra's perception was that teachers were also working together to solve problems and creating unique projects and challenges for students.

Two participants found that creating a shared Google folder was helpful in collaborating on STEM lessons. Three schools noted that requiring collaboration among the teachers was important because it brought teachers who would not normally work together on a unit or lesson. Though it was required collaboration initially, participants noted that it then became ingrained in the school's culture.

Two schools noted that through collaboration and connections in the development and implementation of the STEM program, service projects grew and were integrated into the STEM program. Two participants felt that their connection with the local assisted living community gave them STEM program opportunities, but also, as a part of their faith, and an opportunity to live out one of the Corporal Works of Mercy. Those same participants felt that there were additional opportunities for Corporal Works of Mercy that could come out of the growth of the STEM program. Three other participants noted that the STEM program helped to redefine their parent volunteer program.

Savannah noted that it took their staff nearly five years of required collaboration before it became officially integrated as a part of a teacher's routine. "Teachers dug further into grade level and subject area standards through this collaborative process." Over the years, Savannah collected evidence of integrated and cross-curricular lessons. "It really showed the teachers how far they had come in collaborating with each other."

As a stakeholder, Kristy acknowledged that most schools welcome volunteers to assist in the overall school program. Knowing that parents are invested in their child's education but cannot commit to lunch or recess duty because of their work schedule, Kristy found that parents would work at home in the evenings on STEM challenge bins or assembling a STEM bag for students at the school. That had become a new form of service at their school. Kristy perceived those parents and parishioners had new opportunities to volunteer because of the STEM program. She noted that some of these volunteers would also provide a service to the school community by sharing their STEM career.

Theme Six: Enhanced Interest in Innovation

Participants shared similar experiences and perceptions that developing and implementing a STEM program centered around boosting student interest in innovation. To prepare students for the challenges that they will face, it appeared that a STEM program helped to build student confidence. Developing and implementing a STEM program aligned with differentiated instruction and offered opportunities for students to engage intergenerationally inside and outside of the school community. Some participants felt that introducing students to STEM careers and interests in an elementary level could lead them to considering a STEM related position in the future.

When asked about the purpose of implementing STEM program, some participants responded that their school was committed to current educational trends to boost student interest in innovation. Savannah, STEM coordinator, said that their school historically had great test scores and was successful in their academic programs, but STEM was a piece that helped to tie the curriculum and instruction together. Savannah felt that STEM took their students' thinking to a new level. "By implementing a STEM program, it helped teachers to think out-of-the-box. It helped them to create more meaningful lessons which we found to help boost student interest in innovation."

Maureen, as principal, believed that students were reaching higher potential because teachers were providing more innovative lessons.

Intergenerational Experiences. One school developed within the first two years of beginning their STEM program an opportunity for intergenerational learning, or cross-generational experience. Another school paired older students from one grade with younger students in another grade. These opportunities provided students with experiences to work with others and to have a specific focus in STEM.

Nancy, a principal, said that they paired students in grades three to five and students in grades six to eight in the specially designed courses. "These courses came from teacher interest surveys where they said which clubs or activities, they are willing to coordinate and have an interest in." She noted that it put students together who would not normally work with one another.

Jennifer, a teacher at Nancy's school, referred to the student groupings as cooperative groups where older students can hone their leadership skills. "The cross-generational experience brought our students together in a different way. Since I teach in the 5th grade, it was really neat to see my students interact with the students who were in 3rd and 4th grade."

Emily, a stakeholder, noted that this format moved the students out of the school building and into other sections of the community they would not normally interact with. She said, "I think our biggest intergenerational learning opportunities came when we partnered with a local assisted living community. Students met with an older generation and recorded their lived experiences in a journal." In turn, students then provided lessons to the older generation by teaching them the intricacies of new technology, such as how to operate an iPad™ or other devices.

As students returned from the experience at the assisted living community, they extended their learning in the classroom. Emily said:

> After our first tour of the nursing home community, students came back to school to research residential facilities. The particular facility we partnered with offers regular assisted living, but it also has a rehabilitation unit, a dementia unit, a traditional nursing home. We were exposing them to all aspects of a geriatric person. In science class, students researched Alzheimer's Disease and how it affects mobility. I think our students became more aware of diseases, especially those affecting older persons and really understood that they had something affecting their mobility, or their understanding or reasoning.

Participants at this school felt that students made better connections to their learning, especially in the middle school, when discussing the human body as a part of the curriculum. Emily said that there is a wellness aspect in this intergenerational learning that ties into physical education class and built upon the service aspect that is a part of the Catholic faith.

In another school, Savannah, STEM coordinator, said, "our LEGO Robotics program is one that students really love and enjoy." Savannah explained that LEGO Robotics were LEGO building blocks that also used battery operated machinery and coding to move the designed contraption or parts of the contraption. Savannah said that their LEGO Robotics program is a mixture of elementary and middle school students. Prior to or after a LEGO competition, students display their work to the rest of the school.

She noted that students in the younger grades not only want to be a part of the program, but the older students will also visit with them and teach them at an early age how to work with the building blocks.

Building Student Confidence. Some participants noted that their STEM programs helped to empower students. Their perception was that student confidence was being built through the STEM program, including students with special learning needs. Participants expressed students were able to showcase their talents beyond traditional tests.

Maureen's perception was that they aimed to empower students after they leave their Catholic elementary school with the ability to know they can strive for whatever goal they have set before them. "It can be overwhelming for a student at times, but STEM helps to build their confidence."

As a STEM coordinator, Savannah stated that "students learn to adjust" in the STEM program. She further noted that students who participated in extracurricular activities that are a part of the STEM program find their confidence is strengthened through competitions. She was clear to state that not all the competitions result in a win. Savannah found that students become more passionate about their learning.

Sandra found that their STEM program built confidence, especially for students who have learning needs. She felt these students find their niche. "They are just as proud of showcasing their work as other students." Sandra thought students in a STEM program became more empowered in their learning. In extracurricular activities, Sandra was amazed by the students' own drive and determination during the competition. Students grew from the competition experience, whether it was held within the school or outside of the school. She felt that it gave students a boost with the competitions and festival participation.

STEM Careers. Two schools wanted to expose students to future STEM careers. One used its connections to promote education, but also experiencing trades and skills in the field. The other did so through a speaker series. A speaker series held for certain grade levels opened a pathway for students in Catholic elementary schools to consider a STEM career.

Emily felt that the school's connection to an assisted living facility as well as stakeholders who work in the local technology corporations helped to promote the technology and healthcare industry for their students. Further, she said that the area around the school has seen a recent increase of housing developments. "We definitely promote the construction trades—building, architecture, an electrician, plumbers, welders, and the concrete and wood industries." The school believed that it is allowing students an opportunity to experience a variety of trades and careers to help plant a seed early. Emily felt that skilled labor is a lost art. STEM programs expose students to the value of education and "sometimes, that value is being able to work with your hands and know that is okay. We are investing in their future, wherever that might take them."

The other school opened the door for students to consider a potential STEM career through their STEM speaker series. Savannah said she organized assemblies to provide students opportunities twice a year to hear from experts in a STEM field. "We have had all sorts of speakers from diverse backgrounds. My favorite was when an archaeologist visited to explain how their career was STEM related." Students asked questions and understood that career and how it connected to their current learning, in elementary school. She noted that the speaker series was a way to introduce students to STEM career opportunities. Savanah said:

> Based on the research available, waiting for children to be in high school or in college to then introduce them to something which could potentially lead into a STEM career or interest is too late. You have to expose these kids when they are elementary or in middle school.

Theme Seven: Strategic Planning

A STEM strategic plan provided stakeholders with the school's STEM vision. In it were obtainable goals and objectives that give the teachers and stakeholders a focus and pathway forward. As the STEM program is developed and implemented, sustaining it into the future is important and appeared to be a piece of the planning process. Though challenges to a STEM program existed, such as changes in leadership, or teacher turnover, teachers and stakeholders modified and adjusted where necessary, but continued to advance the STEM vision. The community welcomed different ways to teach and plan, new partners helped grow the STEM program, and other ways to financially support the program.

Strategic planning to develop and implement STEM, as well as sustaining it into the future, was noted as an important step for the school community. It helped to outline the STEM goals, STEM vision, the pathway for STEM implementation and certification, and sustaining STEM as a part of the school's academic program. Participants reported that their schools created strategic plans that outlined the next five years and provided goals and objectives. Participants noted that their strategic plans either included STEM implementation as a goal or created a separate STEM strategic plan. Most were completed with the work of the STEM committee. Two participants stated that their STEM strategic plan outlined everything from the facility to the curriculum.

As a principal, Nancy felt that their connection with the STEM consultant propelled them to organize a formal STEM strategic plan. “Professional development was one of our main goals for our STEM strategic plan.”

Savannah, STEM coordinator, also felt that their school focused on professional development in STEM in their planning. However, “we did not make just an initial focus. Professional development in STEM was written into the plan to continue year after year because we knew that the teachers would need it, especially the new teachers coming on board to our school.”

Maureen’s perception, as a principal, was that their STEM strategic plan helped to keep the teachers and stakeholders focused and organized. “My recommendation was to keep it simple with real and obtainable goals.” Once the STEM strategic plan was created, Maureen noted sharing it with the stakeholders, including the pastor, for transparency and including a timeline for implementation. Maureen said, “our strategic plan for STEM helps our school to organize our STEM goals and share the STEM vision.”

Sustaining STEM into the Future. Participants reported that there should be a plan to sustain STEM into the future. If there is a change in leadership or turnover in the teaching staff, participants felt that a STEM plan provided them with the information needed to advance the STEM goals forward. Other participants noted that sustaining STEM included having mentors available for new teachers who are not STEM trained or aware, a welcome for new families that join the school and are not familiar with a STEM program, developing a better financial plan for supporting the STEM program, and creating a bigger database of STEM experts who are available to support teacher lessons and impart their knowledge and career experiences with students.

At Savannah's school, they had a new principal who took the reins last school year. It was important that the STEM plan was in place because it was the same year that the school became STEM certified through Cognia.

In their planning, Emily felt that the STEM program could grow bigger by inviting more businesses and organizations to participate in the school. "We have been addressing in our STEM strategic plan how to locate those businesses, connect with them, and start that relationship. It is going to help our teachers and students."

Nancy, a principal, hoped that more grants would come available over the next few years as STEM takes hold in the county, especially as more schools, both public and private, attempt to add a STEM program. Nancy felt that she and her colleagues in administration needed to solicit more financial support from businesses and organizations. This way, she said:

> Would make sure that we have the supplies and materials we need for our STEM program. And we really feel like we can make some professional development connections for our teachers to help keep our STEM program going well into the future.

Savannah felt that having mentors available on staff to support teachers, including new teachers, in STEM helped to sustain the program. She believed that adding a STEM coordinator was significant for any Catholic school. However, she also acknowledged that if Catholic school budgets will not allow for it, schools could have one to two designated teachers who are well-versed in STEM and support the teaching staff.

Kenna felt that sustaining stem included mentoring new families on STEM as they are welcomed into the school community. She noted having a developed program for families to understand the STEM program and how they can support it. Kenna reported:

> We do a good job through our parent-mentor program when families are welcomed into our school. And we really get our current parents to help our new parents understand what STEM is and what our expectations are of helping to support it at our school.

Financial Support. Participants reported that a STEM program was funded by a variety of sources, with some stemming from relationships with the parish and the community surrounding the school. Participants felt that there was funding through the school's general operating budget or through fundraising to support their efforts. Fundraising and operating budgets were a source of financing a STEM program, but additional opportunities existed for Catholic schools. Available grants provided support for STEM initiatives. Some participants found success in receiving title funds through the public school district. Additionally, most participants reported that donations from parishioners and from parents added to the support of the STEM program.

As principal, Nancy ensured that they included a STEM line item in the school's budget every year. Nancy solicited STEM sponsors to fund that portion of the school's budget. "Just as a school may sell banners for an athletics program, I sell advertising banners for the STEM program." Teachers used the funds for materials they need or to attend professional development opportunities in STEM. They referred to these advertisers as STEM Partners in the Community.

As a stakeholder in Nancy's school, Emily's perception was that the school had initially secured three major STEM Partners in the Community before it was expanded to include other sponsors. "Those major sponsors came right from when we announced our STEM initiative." Emily stated that she felt Catholic schools have a handicap in the amount of funding that they have versus their public-school counterparts.

Emily acknowledged that their school's annual auction is what has helped to fund the STEM program the past five years. Emily said that with a strong campaign effort, the funds to support STEM education arrive for Catholic schools but can be a challenge for budgeting and teacher planning.

Educational grants from companies and organizations, such as the diocese, helped to support a school's STEM program and initiative. Though some participants mentioned the difficultly of being awarded a grant, some participants have been able to fund a certain aspect of their STEM program because of it. Savannah, STEM coordinator, said:

> We joined a state STEM association to learn more about the availability of grants. Our school was awarded a STEM kickstart grant two years in a row as we began our STEM development. We used that grant money to purchase technology programs.

Additionally, three of the schools that participated in this research recently earned grants from the local electric companies. The grants were tied to a specific STEM goal. One school began their hydroponic garden project while another used the funds to participate in a monarch butterfly program.

Participants reported that title funds through the local public school district were an opportunity to support teacher workshops, professional development, and equitable services. Not all public school district relationships were well developed in certain states and counties between the Catholic schools or Catholic Schools Office, which some participants noted as a challenge to receiving federal funds. However, two schools noted that they have received thousands of dollars in title funds, specifically Title II-A, to hire the STEM consultant and to send teachers to STEM workshops and professional development opportunities. One participant said that other funds that recently became available through the federal government helped to purchase STEM materials for their students. Another participant noted that the local public school district paired the Catholic school teaching staff with a local public school in their zone, who also had a STEM initiative, to attend workshops together. Equitable services provided opportunities for Catholic school teachers to be trained in the same content available to public school teachers.

Though some participants stated that financial donations from parents and parishioners helped the STEM program, donations such as supplies and materials were just as valuable and needed for the school. Participants noted an announcement in the weekly school newsletter or the parish bulletin for materials yielded great results.

Kenna, a teacher, said, “it was definitely called junk, but said it was junk that was needed for students to create and imagine.” Three participants needed old computers so that students could take them a part and learn about all the components. One local chemistry company donated school-approved chemical kits for students to use in their science lab.

Theme Eight: The COVID Effect

The STEM program over the past year in the schools interviewed have been adversely affected by the world-wide pandemic, called COVID-19. It made participants reconsider how they delivered the STEM program to the students. It impacted the learning environment, though principals, teachers, and stakeholders managed the new challenges through technology. There was a sense that when schools ease COVID restrictions in the classroom because STEM has been ingrained in the community, it will take some time but there are clear motivations to move forward in growing the STEM program.

During the time of this research, COVID had created many challenges for the four schools in maintaining their STEM program. Some participants had noted that some of the STEM plans for the year were significantly changed or altered. Some participants witnessed parts of the learning environment changed because of the recommended spacing guidelines. Three participants acknowledged that the shared learning experiences between grade levels was halted in the current academic year because the guidelines recommended maintaining “pods” for classrooms. It was noted that some of the teachers found opportunities to work more directly with their “pods” on STEM projects. Participants responded that STEM festivals were cancelled and other after school activities were postponed due to COVID concerns. One school has postponed visiting the local assisted living community. There were challenges for schools in the current environment to maintain the STEM program as it was planned.

Impact on Curriculum and Classroom. Participants reported adjusting STEM delivery to accommodate for COVID safety needs. Because of COVID, teachers needed to move their instruction from in-person to online platforms. This effected how STEM was delivered to students, especially since collaborating on STEM projects is an important step in developing and implementing a STEM program. Though there were significant challenges, participants noted that teachers became inventive in their design and delivery through the use of technology.

Amy reflected that online platforms helped to continue teacher professional development opportunities in STEM. “We were able to continue our work with our STEM consultant through Zoom and to be able to take workshops on STEM. I needed to get more comfortable with technology too, so the pandemic kind of helped me to do that. And I figured the more I knew about technology by taking professional development workshops, the better I would be for my students.”

Maureen shared that same perception. She said:

> We noted that the digital learner is a STEM certification benchmark. So, our school really took this time of quarantining and started to focus on creating and defining the digital learner at our school. Who are they? And what do they know or need to know.

She found that teachers adjusted their plans, but that new technology discoveries helped move forward the STEM initiative. Maureen found that though collaborative projects may have declined this current school year, teachers have discovered more technological resources to keep their STEM program moving forward. Zoom and other online platforms were used to bring students together who were learning in-person and from home. Overall, Maureen’s perception is that the STEM culture was already ingrained in the school community. Though the STEM program may have been altered in the school because of COVID, it has all the components to get it back on track for the following school year.

Summary

This section discussed the findings based on interviews with a pastor, principals, teachers, and stakeholders who are a part of four Catholic elementary schools located in three different dioceses. Participants described their lived experiences. Participants described the development and implementation of a STEM program within their school and discussed their perceptions about the overall STEM program. Responses yielded eight themes with related subthemes. Participants described the school leadership structure, including the pastor and principal relationship, the role of the principal, and the role of the STEM coordinator. Curriculum and instruction focused on STEM provided the researcher with information on how it was developed and implemented, how participants perceived academic excellence, using school-wide or unit themes to build integrated and cross curricular lessons, and how the engineering design process was a part of all subject areas. Participants described the diverse 21st century learner and their perception of building student confidence through the STEM program and opportunities for intergenerational learning.

The researcher was informed about professional development and professional learning communities that come with a STEM program. Participants described professional retreats and workshops and how evaluations provided feedback on the school's STEM program. Respondents described creating a STEM culture through relationships and support. This included securing financial support, encouraging community partners to participate in the school's STEM program, and the role of a

STEM committee. Participants described the importance of strategic planning to sustain STEM while also presented with various challenges to maintaining a STEM program.

Overall, participants revealed to the researcher their perceptions about their school's STEM program and the vision to develop and implement it. It exposed to the researcher the many challenges that exist in developing and implementing a STEM program in a Catholic elementary school. But it also revealed how the community rallied around and supported the initiative at each of the participating schools. It gave the researcher hope that more Catholic elementary schools may consider expanding their program to welcome a STEM initiative.

CHAPTER FIVE: PROPOSED SOLUTION AND IMPLICATIONS

Introduction

STEM remains a buzzword in the educational world. Strides have been made to bring STEM more to the forefront, but challenges remain in making it more standardized in schools across the United States. One of the challenges includes the traditional approaches to education where subjects are taught individually rather than through an interdisciplinary approach has led to this disconnect (Fan & Yu, 2017). Additionally, K-12 education has failed to provide rigorous STEM related programs and adequately prepare students to be able to problem solve (Fan & Yu, 2017; Sahin & Top, 2015).

Educational policies have helped to address some of the concerns that the United States has fallen behind in innovation (Johnson, 2012). According to Johnson (2012) and the National Research Council (2011), the policies helped to focus schools on the areas math, sciences, and technology so that students were introduced to those skills and enhanced them throughout their K-12 education. Additionally, as students are exposed to STEM skills and careers, it will help to generate an interest in STEM related fields and help to build the skills and confidence to problem-solve (Buckner & Boyd, 2015; South Carolina State Department of Education, 2020). There remains a need to push STEM initiatives further into schools, including elementary schools, and across the board, which would include Catholic schools.

A STEM-focused school helps students to meet their current educational needs (Kloser et al., 2018). Kloser et al. (2018) noted that Catholic schools are embracing new educational models, especially STEM. But developing and implementing a STEM program in a Catholic school takes leadership, time and energy, collaboration, and various resources.

This chapter will summarize the findings of the study. It will also present supporting literature that relates to the findings and the aim of this qualitative study with proposed recommendations that address developing and implementing a STEM program for a Catholic elementary school. Supporting research related to the recommendation and potential challenges to the recommendation are presented in this chapter. Descriptions for implementation and implications for future research and leadership are included. This chapter will close with a summary and conclusion of this qualitative study.

Once the research has been completed, results will be shared with the school leaders and the archdiocesan/diocesan officials. An aim is to present this information at an upcoming NCEA Convention for other school administrators who are interested in the development of a STEM program at their locations or to learn more about stakeholder engagement.

Discussion

The purpose of the study was to explore how Catholic school leaders engage stakeholders in developing and implementing a STEM program. This research helped to establish how principals of a Catholic elementary school should engage stakeholders in the development of a STEM program. According to Lowney (2003), by engaging staff through a shared vision and social influence, and appreciating their value in this transformation, their influence on students and each other emerged. This is supported by Buckner and Boyd (2015) who noted that collaboration through the STEM transformation helped to ensure that best practices and units based on standards, created with STEM lesson criteria in mind, were woven throughout the school. Additionally, another best practice was the introduction of common STEM language. Common language shared in the classrooms and implementing real-world experiences through community partnerships helped to establish connections for students (Sondergeld et al., 2016). Rather than working in isolation, the school staff worked in unison for the betterment of student learning. Meeder (2017) indicated that changing the way a school operated, especially how teachers instruct, was a mindset shift that needed support, patience, and encouragement. Kloser et al. (2018) and Meeder (2017) noted that it was the principal who led the change in mindset and school identity and culture (Kloser et al., 2018; Meeder, 2017).

There was a push to develop an interest and curiosity in STEM within elementary schools, which could support a future STEM workforce, but there was a lack of guidance on how to build a STEM program (Proudfoot & Kebritchi, 2017; Swagerty & Hodge, 2019). Literature was especially limited for Catholic elementary schools to develop and implement a STEM program. The findings from this qualitative study highlight how Catholic elementary schools can develop and implement a STEM program.

Participants identified principal leadership as an important factor in developing and implementing a STEM program. They reported that a principal's ability to include others in decision-making, the development of a STEM leadership team, and the engagement of stakeholders were key components. Findings from previous research supported participation in decision-making and the creation of a STEM leadership team. Schafer (2005) stated that important decisions should be a responsibility of all members of the team. Participating in the development of the STEM curriculum and creating the overall structure of the STEM program were examples participants noted. Principals created STEM leadership teams, which had a positive impact and helped to facilitate the development and implementation of the STEM program. Swagerty and Hodge (2019) noted that elementary schools should create a leadership team for STEM to oversee all aspects of the program. This is supported by Meeder (2017) who had earlier noted that the leadership team helped to support staff in the mindset shift by providing support, patience, and encouragement.

Study participants pointed to relationships with stakeholders and their engagement in the process of successfully helping to develop and implement the STEM program. Stakeholders included educators, administrators, parents, parishioners, students, and community members. Engaging the community helped to transform STEM education and provide opportunities for students to learn from those in the scientific and engineering fields (Kloser et al., 2018). The United States Department of Education (2015) reported that stakeholders, when working together, can identify goals for the school's STEM program and address any challenges that might affect the students or staff. Odhiambo and Hii (2012) found that leadership was the main source of driving stakeholder engagement. Research showed that a principal's leadership helped to develop and implement a STEM program through participation decision-making, a STEM leadership team, and the engagement of stakeholders in the STEM process.

The findings from this qualitative study reinforced the need for Catholic elementary schools to develop and implement a STEM program. The 2015 United States Department of Education's *STEM 2026: A Vision for Innovation in STEM Education* focused on the vision that every young child and person has an opportunity to experience a high-quality and culturally relevant STEM education. Nadelson et al. (2013) wrote that opportunities in STEM can capture the enthusiasm of young learners and expand their STEM knowledge. Furthermore, Dailey et al. (2018) noted that STEM literacy and having knowledge of STEM practices is important for the next generation of workers because there is a growing need for STEM-qualified employees. The educational system needs to prepare students for STEM careers (Dailey et al., 2018). The educational system, according to Kloser et al. (2018), needs to prepare students for the 21st century and that creative problem solving through STEM learning needs to happen through a Catholic lens. The findings supported that STEM education is something not just for public education, but for Catholic schools as well.

According to Sikma and Osborne (2014), schools experienced challenges such as lack of STEM clarity, STEM resources, and STEM professional development in developing and implementing a STEM program. Additionally, Neimeyer et al. (2016) noted that teacher comfortability was an inhibitor to implementing and developing a STEM program. If a teacher was not comfortable with STEM practices or felt inadequately trained in it, their interest in and perception of STEM was affected. Johnson (2012) stated that STEM implementation would encounter barriers, which included interest or a lack thereof, and that STEM is an educational partnership that needs to be sustained through a networking process. Gaps and attitudes regarding STEM must be addressed to help STEM perception (Meeder, 2017). Teachers' knowledge and perception of STEM was significantly enhanced with on-going professional development opportunities in STEM (Nadelson et al., 2013). The challenges in developing and implementing a STEM program in Catholic elementary schools were highlighted in this qualitative research.

Problem-based learning (PBL) was reported by participants and cited in the literature review as being an important component in the development and implementation of a STEM program. Berube (2014) noted that PBL helps to foster a STEM education and students become more comfortable with critical thinking. PBL moves learners to apply their knowledge (Berube, 2014). Participants noted that PBL engaged students and provided authentic learning experiences. There were greater connections made in the learning process for students. A developed and implemented STEM program helps to bring together learning opportunities and hands-on experiences for students to refine their problem-solving skills.

In the literature review, data-informed instruction was identified as a factor in the development and implementation of a STEM program. However, data-informed instruction was not mentioned by the participants. Further research might reveal how stakeholders worked collaboratively or individually to create thematic units or lesson plans that centered around data. Data-informed instruction may uncover better connections to student achievement within a STEM program in a Catholic elementary school.

Aim of the Study

The aim of this study was to create a leadership model that Catholic elementary school principals will be able to adapt within their schools to engage stakeholders in leading STEM curriculum and instruction changes. Developing a STEM program in a Catholic elementary school could boost student interest in innovation and prepare students for future STEM careers. A by-product of a STEM program and environment within a Catholic elementary school may help to keep it competitive and relative in the field of education. For the purposes of this study, STREAM, which includes religion and arts within the acronym, was examined in the context of a K through 8 Catholic school setting.

Proposed Solutions

The proposed solution from this study is a set of recommendations for Catholic elementary school leaders to develop and implement a STEM program. These recommendations focus on developing a STEM committee/assigning a STEM coordinator, designing professional development centered on STEM, establishing program evaluation and stakeholders' feedback, engaging in STEM strategic planning, and creating a STEM culture.

Recommendation: Develop a STEM Committee/Assigning a STEM Coordinator

The introduction of a STEM committee to a Catholic elementary school will enable the school leader to engage stakeholders in the development and implementation of a STEM program. The principal, or designee, creates a formal committee that helps to formulate and design the plan for STEM within the school. The committee is made up of a variety of teachers, support staff, parishioners, parents, and community members. Their knowledge and experiences in STEM will vary. The STEM committee has opportunities to oversee the STEM program, including changes to the school extracurricular programs and curriculum that focus on STEM. The STEM committee can be instrumental in communicating the STEM plan to the stakeholders and will help to shift the mindset of teachers and staff by supporting their journey into STEM.

Assigning a STEM coordinator can help a principal to organize and evaluate their STEM program. A STEM coordinator can be a specific position within the staff or could be another role assigned to a teacher as a part of their daily responsibilities. The STEM coordinator can help facilitate professional development opportunities for teachers, give feedback and support to individual teachers in STEM, and create STEM experiences for students. The STEM coordinator can help implement the STEM vision for the school and tie critical components of developing and implementing a STEM program together.

Recommendation: Design Professional Development Centered on STEM

On-going professional development for staff centered on STEM enhances their knowledge and comfort in implementing STEM. To have a fully developed and implemented STEM program within a Catholic elementary school requires the teachers and staff to be a part of the process and to be able to bring a STEM curriculum into the classroom. Allocating sufficient time for professional development and opportunities for teachers to evaluate STEM resources is an important step in the STEM development and implementation process. Professional development should be scheduled and built into the professional development calendar for teachers. STEM should be then the main focus of all professional development for not just one year, but until the STEM program has been fully implemented within the Catholic elementary school. Teachers should be given additional time for professional development to learn from other STEM schools and from other STEM resources, such as the University of Notre Dame's Trustey Family STEM Teaching Fellows program or the National Catholic Educational Association's STREAM conferences. Outside resources should be brought into the school such as consultants who focus solely on STEM integration in the classroom. It provides teachers with an opportunity for a one-on-one or small group interaction with the consultant and to ask specific questions about STEM implementation. Professional development in STEM needs to be on-going and should support teachers in their experiences and learning.

Recommendation: Establish Program Evaluation and Feedback

Establishing program evaluation and engaging in receiving feedback are two important recommendations for the development and implementation of a STEM program in a Catholic elementary school. Program evaluation allows for the community to give feedback to the school leadership team about the STEM programs' strengths and weaknesses. It provides an outside perspective and may help to bring new ideas to the STEM program. Evaluating the STEM program also gives students a chance to reflect on their learning experiences and to suggest alterations to the STEM program, especially for extracurricular activities that they may like to have added to the school.

Teacher feedback is key in developing and implementing a STEM program because it gives the principal and STEM committee important information about the process. Teacher feedback on STEM development, STEM resources, and STEM professional development are important so that the principal and STEM committee are aware if goals and objectives are being reached or what areas of concern need to be addressed before moving forward in the STEM process. Receiving teacher feedback also gives an opportunity for teachers to share their experiences and their interests so that more productive conversations and collaborations around STEM can be established. Program evaluation and receiving feedback can be critical in a school's STEM program development and implementation.

Recommendation: Engage in STEM Strategic Planning

A strategic plan lays out the school's STEM vision. It provides obtainable goals and measurable objectives and provides the staff with a charge in moving STEM forward within the Catholic elementary school. Though school leadership and staff may change, the strategic plan is an institutional piece that outlines the pathway for STEM success, including recognition through a STEM certification process such as Cognia STEM Certification. A strategic plan includes engaging in professional development opportunities, obtaining financial resources and support, timelines for implementation, the vision and purpose, and focuses on continuous improvement. Creating a STEM strategic plan will help schools to sustain it well into the future.

Recommendation: Create a STEM Culture

Creating a STEM culture is a mindset shift within the community. It moves from traditional approaches to education to a focus on STEM and innovation. STEM fairs and showcases, STEM challenges, makerspaces, and the Engineering Design Process (EDP) are all opportunities to introduce STEM to stakeholders, especially students. STEM showcases and fairs allow for teachers and students to express their talents and problem-solving skills in an open forum. They are interactive and can be done internally or externally. Participating in an external showcase or fair gives schools a chance to exhibit their talents and puts them on the same playing field as other STEM focused schools. For schools that are beginning their STEM program focus, starting with STEM challenges is a common way to begin exposing both teachers and students to STEM critical thinking.

Makerspaces are designated communal areas for learners to engage with others or work individually on projects. Establishing a lab, an area of a classroom, or portion of the library as makerspace is an important step for students to be able to create, think, explore, and design.

Learning the steps of the EDP gives learners in each of their subjects to focus on identifying the problem, research the problem, imagine possible solutions, planning a solution, creating a prototype, testing it, and improving it. The EDP can be used from science and math to writing and religion. Extracurricular activities, aside from athletics and general interests, are brought into the fold as opportunities increase for students to experience STEM related fields. They provide unique ways for students to explore their world and their interests outside of the classroom experience. Each of these opportunities help to shift the mindset within a school and create the STEM culture.

Recommendation: Engage Stakeholders

Successful stakeholder engagement led to the development of a STEM program. A principal working closely with the pastor, staff, and internal leadership teams, such as the school advisory council, are the first steps to begin sharing the vision and establishing the school's focal point. External leadership teams, community support, and other diocesan support, such as from the bishop and superintendent, help introduce real-world experiences for students and extended the learning process for students. By bringing stakeholders together and motivating them to support the Catholic elementary school, it can help to improve the academic program and development of the STEM program.

Evidence that Supports the Solution

Participants in this study noted that developing and implementing a STEM program in a Catholic elementary school will take time. The principals, STEM coordinators, and teachers all noted that STEM was an important part of their school, but that it took time to ensure what they felt was a quality program was created and then presented in the classrooms. For some participants, they were not sure what STEM was or how it looked. For participants to feel more comfortable in STEM, they noted that professional development was the key.

According to the research, teachers need continued support, through professional development, to be better prepared to teach STEM and to improve their self-confidence and efficacy in STEM (DeJarnette, 2018; Nadelson et al., 2013). Professional development needs to be ongoing, models how to implement differentiated instruction, and provides teachers with opportunities for follow up (Dailey et al., 2018). Additionally, hands-on professional development experiences give teachers chances to understand the STEM practices and can transfer them into the classroom, becoming change agents rather than just implementing an isolated skill (Dailey et al., 2018). Moreover, teachers have opportunities to share their learned ideas through a professional learning community or through peer mentoring (Dailey et al., 2018).

Teachers can see more cross-cutting opportunities through professional development. Professional development in STEM gives context to how to integrate and cross-cut STEM practices into other disciplines (Dailey et al., 2018). Dailey et al. (2018) and DeJarnette (2018) both noted that, in an elementary school setting, teachers are limited on time to teach engineering and science. With ongoing professional development, Dailey et al. (2018) stated that teachers can teach STEM across the disciplines through cross-cutting practices, adding engineering and science to other disciplines, thus affecting overall student understanding.

A STEM committee can support the principal in their leadership role, help to share the vision, and determine the best practices of STEM (Zubrzycki, 2015). They can help to integrate STEM into the school and be able to understand the meshing of the Catholic faith and STEM components (Convey, 2012; Kloser et al., 2018). Furthermore, the STEM committee can help establish networking opportunities in STEM, uncover STEM resources to help support teachers, and can address issues in the development and implementation of the STEM program (Johnson, 2012; Swagerty & Hodge, 2019).

The STEM committee can evaluate curriculum and programs that will support the STEM initiative. Teachers shared that they are unprepared to teach the newest STEM concepts, such as Next Generation Science Standards (NGSS) (DeJarnette, 2018). Members of the STEM committee can assist in this review of components such as the NGSS and provide support to the teachers on STEM implementation.

Shifting the school's culture to a STEM focus is an important step in the process, according to some of the participants in this study. Slowly adding STEM components, such as makerspaces or participating in STEM fairs or showcases, are initial steps schools can take to start dipping into STEM. Holter (2017) found that makerspaces and other venues help to promote investigative learning and should be a part of the school's plan to develop a STEM program. Students begin to explore in these STEM opportunities and it helps to build student confidence (Holter, 2017). Additionally, Swagerty and Hodge (2019) observed that opening a STEM lab on campus not only benefits the students, but it benefits the teachers too who then can model effective STEM teaching practices to other teachers. The STEM spaces should be flexible and allow for students to work collaboratively on projects (Swagerty & Hodge, 2019). Problem-based learning is a step that can be gradually implemented into the school's culture. Most teachers are not initially comfortable with PBL but designing a lab or space within the school can help students to explore and engage in PBL (Swagerty & Hodge, 2019).

According to Derry and Wilcox (2021), participating or hosting STEM festivals bring different members of the school community together. They help to initiate STEM activities and discussions around STEM that are needed to advance the school's development of a STEM program forward (Derry & Wilcox, 2021).

The school's STEM culture also welcomes teacher feedback and reflection. According to Nadelson et al. (2013), teachers' confidence in STEM will grow if they have time to reflect on what they are teaching or what they have learned through experiences. Teachers experiencing outside programs through colleges or universities or programs that are designed specifically to support STEM integration will help to build the STEM culture (DeJarnette, 2012; Nadelson et al., 2013). An example of an outside program would be a private business who may host a summer STEM camp for teachers or students (Dailey et al., 2018). Additionally, DeJarnette (2012) found that STEM consultants or STEM teachers in colleges or universities can help facilitate the development and implementation of a STEM program for a Catholic elementary school by imparting their knowledge onto elementary school teachers.

Finally, the STEM culture will grow with planning. Modeling a STEM strategic plan from other STEM schools or school systems, such as *STEM Strategic Plan: An Integrated K-12 STEM Proposal for Tennessee* written in 2018, will help further the development and implementation of a STEM program in a Catholic elementary school. Utilizing Cognia's STEM Certification program will help to shape the STEM strategic plan. The continuous monitoring and updating the STEM strategic plan helps to identify areas of strengths and weaknesses in planning for STEM (Dailey et al., 2018).

Evidence that Challenges the Solutions

There are some challenges to developing and implementing a STEM program for a Catholic elementary school. The first is being able to move away from a traditional approach to Catholic education. It took nearly five years after the Obama's administration announcing STEM initiatives throughout education in the United States before the National Catholic Educational Association (NCEA) held a conference on STEM (Zubrycki, 2015). Additionally, Kloser et al. (2018) acknowledged that it was challenging to integrate Catholic identity into STEM and the religious environment. Catholic schools may still be struggling with how to mesh traditional approaches to Catholic education with STEM.

Some Catholic schools have focused on the classical studies approach to education. There are some that focus on the arts, sciences, and literature through ancient cultures and acquiring wisdom through those experiences (Duin, 2011). Duin (2011) argued that classical curriculum is rooted in the Catholic Church. Beeson (2015) supported this argument by asserting education is seen as too progressive and classical education is a way to reconnect to traditional ways of learning, based on ancient Rome and Greece.

Another challenge is that there is the perception that STEM education discounts a liberal arts education. Zakaria (2015) wrote that the perception suggests that liberal arts education is irrelevant, and that technological training is the only way to stay competitive in the global market. Zakaria (2015) argued that a broader approach to education leads to better critical thinking skills and creativity. Though math and science are important, writing and reading are critical for a student to know how to do as well (Zakaria, 2015). Furthermore, Zakaria (2015) felt that too much is focused on automation with STEM and it does not allow for flexibility or using learned judgement. Innovation, Zakaria (2015) argued, is more than technology and engineering, but understanding how society operates. A challenge is that there are some who say there should be a broader approach to education, not just STEM.

Finally, others argue that STEM education is too narrow (Zaloom, 2019). Because it is defined as being too narrow, it limits students from receiving a more exploratory education (Zaloom, 2019). An exploratory education would include opportunities for students to enhance their soft-skills such as writing and communicating (Zaloom, 2019). STEM education focuses on STEM careers, but Zaloom (2019) argued that jobs are currently being designed to be temporary. Education should not be reduced to preparing students for jobs and students should be able to experiment with a variety of educational experiences (Zaloom, 2019).

Implementation of the Proposed Solutions

As a leader of a Catholic elementary school, a principal will want to first determine if a STEM program would be welcomed within its community. A principal will need to address any perception issues about STEM and be able to communicate with the pastor, superintendent, and school advisory council about implementing a STEM program. Then the principal will need to address the teachers about the new STEM focus and the following stages the school will take to develop and implement the STEM program.

Stage One: Establish a STEM Committee

A principal will need support in moving the school into a STEM direction. The STEM initiative can be supported by establishing a STEM committee, which should be representative of the teacher community and include those who have familiarity with STEM and those who do not. Members of the committee should encompass the school's grade bands, i.e. kindergarten through second grade, third through fifth grade, sixth through eighth grade. Members should have various backgrounds and experiences and should include members who have talents such as the art teacher, music teacher, or similar. A STEM committee needs to include teachers who are experienced in certain subject areas, such as math and science, but also ensure that religion and language arts are represented. The committee should begin meeting with the principal on a regular basis and create the STEM vision through a strategic plan.

Stage Two: Develop a STEM Strategic Plan

The STEM committee should next welcome members from the community to be a part of the STEM planning process. These stakeholders would include parishioners, parents, and various community members who have experiences in STEM fields or STEM education. They can partner with the principal and committee to devise the STEM vision and begin to piece together the STEM strategic plan. The plan can be modeled from other STEM strategic plans that have already been created by Catholic schools, public schools, or school systems. The plan should address curriculum and instruction, professional development, finances and resources, engaging stakeholders and forming partnerships, and obtainable goals and measurable objectives. Once the plan is developed, it should be shared with the greater school and parish community so that there is a clear understanding of the mission and vision of the school's journey into STEM.

Stage Three: Implement the STEM Professional Development Plan

As research showed, teachers may be unprepared and uncomfortable with integrating STEM into their classrooms. Helping to create a plan for professional development opportunities in STEM will help teachers to feel more at ease with incorporating STEM. A principal and the STEM committee should begin to evaluate workshops, conferences, STEM consulting companies or individuals, colleges and universities, and educational organizations to determine which best fits their professional learning goals and the budget. Once it is determined what fits best, the principal and STEM committee should plan for on-going professional development through the selected opportunity or opportunities that lasts not just through the school year, but for the foreseeable future. Principals need to also ensure that there are chances for teachers to put into practice what they have learned from the professional development opportunity. Teachers should also be able to provide feedback on the professional development opportunity and be able to work in their established professional learning communities to learn from each other in addressing the school's STEM goals. As teachers learn and are becoming more comfortable in STEM, it is time to start adding STEM components to the school's program.

Stage Four: Create a STEM Lab/Makerspace and Participate in STEM Fairs

In this research, some of the participants interviewed noted that using any available space for a lab or makerspace was important for their first steps in STEM. A principal and the STEM committee should evaluate areas in the school that can become the STEM lab or a makerspace. The spaces should be outfitted with supplies and materials, either purchased or donated, that help a student or group of students to begin exploring, creating, designing, and improving. With the lab or the makerspace, students can be provided STEM challenges that help to introduce them to problem-based learning. Teachers can sign up to use the STEM lab or makerspace with their classes throughout the week. At first, they may be isolated events or focused on a particular challenge not necessarily related to the content students are currently learning, however, over time, teachers will be able to use the lab and makerspaces as opportunities for students to connect what they learned in the classroom and apply it in a hands-on experience.

The principal and STEM committee should look for opportunities both within the school day and outside of the school to participate in a STEM fair. STEM fairs may include a STEM night held at the school or a STEM showcase that helps to display student work in STEM. These STEM fairs help to engage the larger community of parents and friends who may be able to help lend a helping hand in the STEM journey. The principal and STEM committee can also see what available STEM fairs are being held locally so that students can experience an outside challenge and be able to showcase their work against other STEM schools.

Stage Five: Establish Partnerships with Stakeholders

Establishing partnerships for the school can help to bring in valuable resources. These resources would include financial support or human resources. A STEM initiative is going to need some financial support, especially for teachers to be able to attend professional development opportunities into the future. Financial support may also help to provide grants to begin STEM initiatives at the school.

Human resources are those with STEM knowledge or who work in a STEM field and can offer their services to the school either by training the teachers, being a field expert who can speak to the students about their role, or welcoming teacher and students to their organization or company for a field experience. Partnerships with local colleges or universities might help to pave a way for teachers to learn about STEM resources or to be able to receive material that can be useful in the classroom setting. Though there are marked differences in Catholic schools versus public schools, a Catholic school may be able to establish a partnership with a local school district or STEM school to learn about available resources, to observe the STEM school, and to connect on workshops or showcase events.

The principal and STEM committee can use resources such as the parish bulletin, surveying the parents, and contacting local organizations to begin establishing these partnerships. The Catholic Schools Office and the pastor may also have other connections that would benefit the school's STEM program. Depending on the other schools in the diocese, there may be other Catholic schools that have started or implemented a STEM program that can be partnered with to establish a larger network.

Stage Six: Reshape the School's Program

As the school moves towards implementing its STEM program, pieces of the school will need to be reevaluated and reshaped. These include the curriculum and instruction as well as the school's offerings for extracurricular activities. The curriculum and instruction should begin to move away from the traditional approach to teaching to a more innovative approach. Teachers should be implementing material from their learned experiences through professional development. A principal may ultimately choose to give teachers some leniency on incorporating STEM initially, but then gradually move towards requiring it in the classroom on a regular and daily basis. To help facilitate STEM being brought into the classroom, STEM lesson planning sheets or STEM calendars can help teachers to monitor how much and how often they are bringing STEM into their instruction. Over time, a principal will want to observe teachers and classrooms to ensure that STEM is being adequately carried out and that students are having greater opportunities for hands-on learning experiences and challenges.

Extracurricular activities can be added within the school day or outside school hours. This may involve adding new classes to the school's course offerings such as drama class, engineering, STEM lab, or a foreign language. Outside of school hours, new activities can be introduced that are STEM focused such as a robotics team or a coding workshop. It is from the established partnerships that schools may be able to add these new experiences for students.

Stage Seven: Become STEM Certified

It is one thing for a school to say it has a STEM program. It is another for it to say that it is STEM certified. Becoming STEM certified is when an external evaluation committee comes into the Catholic school and, using evidence and observations, and affirms that school's STEM program. There are educational organizations that complete the STEM certification for schools. Many would be familiar with Cognia as the accrediting body used by many schools across the United States. The principal and the STEM committee should review the indicators and standards of Cognia's STEM certification process and begin to collect supporting evidence. The principal and STEM committee should engage the representatives at Cognia and begin the process of establishing a timeline for an external review. The principal and STEM committee will need to complete paperwork associated with the process and write summaries for each of the indicators. The school has a unique opportunity to become STEM certified and join the small but growing list of Catholic schools in the United States who are STEM certified through Cognia.

Factors and Stakeholders Related to the Implementation of the Solution

There are three factors to consider related to the development and implementation of a STEM program for a Catholic elementary school. They are buy-in, partnerships, and accountability. The principal must work to present why STEM is important for the school community to engage. They must have buy-in from the teachers, the pastor, the parents and school advisory council, the superintendent, the parish and parishioners, and the greater community. The principal must be prepared to address the perceptions about STEM and to be able to explain the importance of beginning a STEM program at the school, using research and advice as supporting evidence.

For a STEM program to be successful, it relies on positive partnerships that help to meet and exceed the goals and objectives written in the strategic plan. Partnerships help to bring financial support and human resources to the school's STEM program. Should a school fail to have established partnerships, it will greatly affect the professional development needs of the staff, the learning opportunities for students and teachers, and the experiences for teachers and students in STEM related fields. STEM is about making connections in the learning experiences. Without partnerships, the connections that the students and teachers will hinder its STEM focus.

Finally, accountability is another factor in the success of the STEM program. For the STEM program to work towards becoming STEM certified, everyone who is a part of the process needs to be held accountable. The principal should be held accountable by the teachers, and the teachers held accountable by the principal. The STEM committee should also be held accountable as they are an instrument in helping to facilitate the STEM vision and implementing the STEM strategic plan. Partners who fail to produce what was expected of them without cause or reason can adversely affect the STEM program. It is everyone coming together for a STEM program that makes it successful across the school, not just in pockets or particular grade bands.

Timeline for Implementation of the Solution

The timeline for implementation of a STEM program is three to five school years. The first year should be spent building up the cause for developing a STEM program. It would also include establishing the STEM committee and writing the STEM strategic plan. The second year would focus on the professional development needs of the teachers and starting to align the partnerships that will be important along the STEM journey. Within the second year, changes to the curriculum and instruction would need to be implemented. Additions to the school’s extracurricular program can be included in these first two years. The second year would be an opportunity for STEM showcases and fairs to take place as well as creating makerspaces and STEM labs within the school. The third year would then be the first full year of a developed and implemented STEM program. With the third to fifth years of implementation, seeking STEM certification would be the final step in the process.

Because collaboration is an important piece in developing and implementing a STEM program, much of the first two years of this process will be invested in grooming relationships and establishing how groups will work collectively. It involves the buy-in from all stakeholders, which will not come all at once and will take time. The task of the STEM committee is to help support the principal in that role and to help bring everyone together to work on the STEM program.

Evaluating the Outcome of Implementing the Solution

To evaluate the success of the implementation of a STEM program in a Catholic elementary school, as a part of the strategic plan, it should include how the school will measure its program's achievements. In *STEM Strategic Plan: An Integrated K-12 STEM Proposal for Tennessee* written in 2018, achievement was listed as a priority and included being able to measure academic success to ensure that the STEM program is successful. Other areas of achievement would include generating a list of partnerships that have been established, recognizing the financial resources that have been obtained to help support the STEM program, and aligning STEM standards to the school's curriculum and instruction. The school should consider the Cognia STEM certification indicators on a yearly basis and use it as a reference guide when completing an end-of-the-year reflection. The indicators can help provide an internal audit on the STEM program and determine if the school is not meeting, approaching, meeting, or exceeding the indicator.

A system of seeking teacher feedback needs to be established. Teachers should be afforded time to reflect on their STEM experiences and share with their professional learning communities (PLCs) or the STEM committee. Teachers can do this through surveys or web forms as well as through open forums and conversations at staff meetings or within the PLCs. Teachers should give feedback on the STEM program, their professional development opportunities, and their observations of implementing STEM in their classrooms. Teacher feedback is valuable and should be a continuous part of the evaluation process.

One additional evaluative piece is to seek comments from parents and parishioners about the STEM program. This can also be done through a survey and will yield information about how transparent the school is regarding the STEM program. It gives the community an opportunity to share their thoughts about STEM and what areas that the school may need to address in the STEM strategic plan.

Another useful technique would be to invite the superintendent of Catholic schools, another principal from a neighboring Catholic school, or an external community member who is familiar with the strategic plan and the school's STEM purpose to visit and observe on a regular and yearly basis. Their reflections about the school's STEM program will give an external observation that would be important for the principal and STEM committee to consider. The external visitor should use the Cognia STEM indicators as their guide for the school review.

Implications

Practical Implications

This study was designed to explore how Catholic elementary schools developed and implemented a STEM program. The first practical implication of this study is the importance of establishing a STEM program. Though not all Catholic elementary schools will proceed to the final stage of seeking STEM certification through an accrediting body such as Cognia, producing a STEM program is an important step for Catholic schools throughout the United States. The United States has fallen behind in innovation (Johnson, 2012). Approximately 80% of today's jobs require knowledge of math and science, and applicants for those positions lack competencies in math, computer, and problem-solving (Johnson, 2012; National Research Council, 2011). To rectify this, Fan and Yu (2017) found STEM education provided students with the ability to approach real-world problems and solve them with strategies presented. The South Carolina Department of Education (2020) supported this by stating STEM education helped build student confidence to problem-solve and express themselves creatively. STEM education generates the skills that are essential for success needed in future endeavors (Verner, 2018).

The second practical implication is that teachers often encounter miscellaneous experiences in professional development that may or may not relate to their line of work. STEM is cross-cutting and it hits upon every subject area and core content. With a school having a STEM focus, the professional development then becomes more focused. Teachers gain STEM experiences in new learning strategies and behaviors (Johnson, 2012). STEM allows for teachers to go in-depth into the standards and benchmarks and to align them into a curriculum that is effective in helping student engagement (Roach et al., 2008). A STEM professional development plan will have a positive impact on teachers and the work that they are doing in the classrooms.

Implications for Future Research

This study should be helpful to leaders of Catholic elementary schools who are aiming to develop and implement a STEM program in their school. Future research should further explore other Catholic archdioceses/dioceses and their STEM focus. It is possible that other states where archdioceses/dioceses are located have a different approach to STEM or the population would impact the STEM focus. Exploring other Catholic elementary schools that have a larger institutional size may be beneficial and give a comparison between smaller and larger Catholic schools and their effectiveness in developing and implementing a STEM program.

Future research may investigate if Catholic archdioceses/dioceses have created a STEM template for Catholic elementary schools to follow to create a STEM program. Currently, there are no known processes in place except the Florida Catholic Conference's Education Department, which helps to oversee Catholic education in the state, had begun work on establishing protocols. Their website lists the 14 STREAM certified Catholic schools in Florida but there are no links to how a school becomes STREAM certified. If archdiocesan/diocesan Catholic Schools Offices wish to have more Catholic schools developing and implementing a STEM program, it would be worthwhile to explore if there is support and guidance.

Future research may consider collaboration between Catholic elementary schools and Catholic secondary schools on how to incorporate STEM into their schools and to share resources. Some of the research showed that there are available resources but that they are not always shared between sites. Understanding how schools establish their STEM partnerships may provide some insight into how Catholic schools work together to develop a STEM program.

Implications for Leadership Theory and Practice

The aim of this study was to create a leadership model that Catholic elementary school principals will be able to adapt within their schools to engage stakeholders in leading STEM curriculum and instruction changes. First, this study adds to the literature regarding a STEM program in Catholic elementary schools. Prior to this study, there were no known studies completed on Catholic elementary schools and STEM education. There is much written about Catholic education embarking in the new millennium through the 1990s and 2002, such as *Renewing our Commitment to Catholic Elementary & Secondary Schools in the Third Millennium* (2005), but there is little documentation that exists that address Catholic education and the sciences. However, based on the literature review, Catholic education is evolving (Denig & Dosen, 2009). It is evolving through leadership and including educational concepts such as STEM. It is school leaders who want to bring or improve STEM into their schools and the desire to have rigorous learning experiences for their students and open all avenues for students to be engaged in STEM learning and literacy (Buckner & Boyd, 2015; US DOE, 2015). At the elementary level, STEM needs to be exposed to students because that is when they develop their perceptions and knowledge of STEM (Dailey et al., 2013). This implies that Catholic school leaders, who are helping Catholic education evolve, need to be transformational and implement best practices. Catholic school leaders should incorporate STEM into elementary schools to expose students to STEM experiences and help plant the seed early in their education.

With additional ideas about the implications for practice, school leaders should consider recognizing community and stakeholder support to lead change. Through shared leadership, principals develop relationships with stakeholders to advance the school's mission and vision. With a STEM initiative, principals expressed how important it was to maintain and sustain relationships with community stakeholders because it was their shared leadership that helped create the STEM program. These partnerships proved invaluable to help move the school forward in the development and implementation of a STEM program.

Summary of the Dissertation in Practice

The purpose of the study was to explore how Catholic school leaders engage stakeholders in developing and implementing a STEM program. A phenomenological study was created to evaluate the lived experiences of a pastor, principals, teachers, and stakeholders as they developed and implemented a STEM program within their respective Catholic schools. The sample for this study were members from four total Catholic elementary schools located in South Carolina, Maryland, and New Jersey. Participants in this study included a pastor, three principals, two STEM coordinators, six teachers, and four stakeholders. Participants were selected by the school principal. Interviews were conducted by phone using 13 open ended questions. Eight themes emerged during the analysis of the transcripts: (a) shared leadership, (b) professional development, (c) curriculum and instruction, (d) STEM program evaluation, (e) STEM culture, (f) enhanced interest in innovation, (g) strategic planning, and (h) the COVID effect.

The findings revealed that a principal sharing their STEM vision and engaging community stakeholders in the STEM process were critical to the school's STEM development and implementation. The partnerships that were established helped to create a unique opportunity for each of the schools to showcase their STEM talents and to gain additional opportunities to expose students in the elementary grades to STEM fields. The principal establishing a STEM committee was important for the shared leadership approach but also helped significantly in developing the STEM strategic plan as well as helping to share the vision of STEM for the Catholic elementary school. The STEM strategic plan facilitated steps for on-going professional development, changes to curriculum and instruction, and establishing a framework for program evaluation and feedback. Because of COVID, the participants revealed some of the challenges that they faced this past school year in continuing to provide STEM based lessons in the classroom. Many of the key components of a STEM program, including student collaboration, had to stop. However, participants revealed how the pieces of their STEM program changed for the better and that the STEM strategic plan was the basis for their STEM focus. Without the STEM strategic plan, it is possible that the school would lose its STEM focus.

The implementation of the proposed solution requires a principal sharing their vision and their leadership with stakeholders. To effectively implement the proposed solution, principals will need to develop a STEM committee that can help to lay the STEM vision and create measurable goals and objectives to developing and implementing a STEM program. As more partnerships and relationships are established, the further teacher professional development in STEM and opportunities for students in STEM fields will grow. Catholic elementary schools can grow their STEM program by taking small steps first and then expanding it through resources and networking. In conclusion, a Catholic elementary school developing and implementing a STEM program will ensure that students have unique opportunities to explore their world though quality, hands-on learning experiences and through curriculum and instruction that is aligned with STEM standards.

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Appendix A

Interview Protocol: STEM Curriculum and its Effect on Catholic Elementary Education and Stakeholder Engagement

Time of Interview:

Date:

Place:

Interviewer: Christopher A. Trott

Interviewee:

Position of Interviewee:

(Briefly describe the project. Include statements of appreciation and introduction. Such as: Thank you for agreeing to be interviewed for this research project on _______. I want to remind you that your comments will remain confidential and anonymous. Have them sign the consent form. Let them know they can take a break at any time and that they can ask you if they have any questions, etc.)

Questions:

1. What has been your role in introducing STEM curriculum and programs into your Catholic elementary school?
2. What has happened to your students' standardized test scores since the introduction of STEM curriculum and programs into the learning environment?
3. What has been the influence of student-centered instruction within your learning environment?
4. Can you give me an example of a STEM lesson that was effective? How did you know it was impactful for the students?

5. How do you typically meet the needs of individual students? Can you describe differentiated instruction?
6. Have the Norms of Collaboration been introduced to the school community? Is it modeled by the faculty and staff and what impacts have the norms had on student learning and engagement?
7. If you know no one could ever trace or know where the response came from, what would you tell me about how the faculty and staff took to the curriculum changes when it was introduced?
8. What do assessments look like in your school?
9. What does the STEM learning environment and STEM integration look like in your school?
10. Describe how feedback is given to the faculty and staff? To the learners/students?
11. Tell me how learners communicate with and use digital tools/technology to conduct research, gather/evaluate information, solve problems, and/or create original works.
12. Explain your perception of how the culture of the school has changed since the introduction of STEM curriculum/programs.
13. If there is something more you'd like to add about STEM curriculum/programs within this learning environment that I have not asked please describe that for me.

Additional questions for depth and breadth to the above questions:

Would you expound on that?

Tell me more.

How would you describe that in a different way?

I would like to hear more about that.

Would you clarify that for me?

What was the effect of that incident?

What were the consequences?

What was your reaction to that behavior?

Take me through your thought processes during that time.

Appendix B

Example Letter to Participants

DATE:

Dear Participant,

The purpose of this research is to detail how Catholic elementary schools have developed or are developing their STEM (Science, Technology, Engineering, and Mathematics) programs. As STEM continues to grow, it is important for Catholic schools to evaluate how it can be best implemented into their academic and spiritual program. From this research, the hope is to be able to explain how Catholic schools can engage all stakeholders in supporting this shift in the school's program. Your responses will help to provide details about your personal experiences with STEM and your school's STEM journey. Know that your participation in this study is voluntary and can be withdrawn at any time.

There are no risks in participating in this study. There are also no direct benefits or compensation that can be expected from participating.

Data collected from this study, such as phone transcripts and Zoom recordings, will be kept confidential by redacting interviewees names and school. These will be stored in a password protected Google Drive document, on a secure file in the researchers' server, and/or within a locked filing cabinet in the researchers' office. When the final report is written, your name will be withheld or changed.

For specific answers to questions about the research, please contact me at 843-505-3644 or cat53844@creighton.edu. You may also contact my chair, Dr. Barbara Brock, Professor Emeritus at Creighton University, at barbarabrock@creighton.edu or my advisor, Dr. Candace Bloomquist, Assistant Professor at Creighton University, at candacebloomquist@creighton.edu.
If you have questions about research participants' rights, please contact the Institutional Review Board at 402-280-2126.

Sincerely,

Christopher A. Trott, Principal Investigator

Bill of Rights for Research Participants

As a participant in a research study, you have the right:

1. To have enough time to decide whether or not to be in the research study, and to make that decision without any pressure from the people who are conducting the research.

2. To refuse to be in the study at all, or to stop participating at any time after you begin the study.

3. To be told what the study is trying to find out, what will happen to you, and what you will be asked to do if you are in the study.

4. To be told about the reasonably foreseeable risks of being in the study.

5. To be told about the possible benefits of being in the study.

6. To be told whether there are any costs associated with being in the study and whether you will be compensated for participating in the study.

7. To be told who will have access to information collected about you and how your confidentiality will be protected.

8. To be told whom to contact with questions about the research, about research-related injury, and about your rights as a research participant.

9. If the study involves treatment or therapy:

    a. To be told about the other non-research treatment choices you have.

    b. To be told where treatment is available should you have a research-related injury, and who will pay for research-related treatment.

The Bill of Rights for Research Participants may also be found online.

Appendix C

Sample Letter from Catholic School Leaders

Letter of Agreement

DATE

We are familiar with Christopher A. Trott's research project entitled Catholic Schools and STEM (Science, Technology, Engineering, and Mathematics): An Exploration of How Catholic School Leaders Engage Stakeholders in Developing and Implementing a STEM Program. I understand our Catholic elementary school's involvement is to provide information about our school's STEM program and its development through phone interviews. We understand that the principal investigator is seeking feedback from various stakeholders from the school, including the Catholic elementary school's pastor, principal, teachers, parents, and community partners.

We understand this research will be carried out following sound ethical principles, that participant involvement in this research study is strictly voluntary, and confidentiality of participants' research data is ensured, as described in the protocol.

Therefore, as a representative of our Catholic elementary school, I agree Christopher A. Trott's research project may be conducted at our school.

Sincerely,

[Name and title of Catholic Elementary School]

Appendix D

IRB Approval Letter

Creighton
UNIVERSITY

Office of the Provost
Research Compliance

DATE:	18-Aug-2020
TO:	Trott, Christopher
FROM:	Social / Behavioral IRB
PROJECT TITLE:	CATHOLIC SCHOOLS AND STEM (SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS): AN EXPLORATION OF HOW CATHOLIC SCHOOL LEADERS ENGAGE STAKEHOLDERS IN DEVELOPING AND IMPLEMENTING A STEM PROGRAM
REFERENCE #:	2001311
SUBMISSION TYPE:	Initial Application
REVIEW TYPE	Exempt Category 2
ACTION:	APPROVED

Thank you for your submission of Initial Application materials for this project. The following items were reviewed in this submission:

- Creighton University HS eForm
    - Trott Proposed Project and Methodologies
    - Trott Interview Questions
    - Information Notification to Participants

This project has been determined to be exempt from Federal Policy for Protection of Human Subjects as per 45CFR46.101 (b) 2.

All protocol amendments and changes are to be submitted to the IRB and may not be implemented until approved by the IRB. Please use the modification form when submitting changes.

If you have any questions, please contact the IRB Office at 402-280-2126 or irb@creighton.edu. Please include your project title and number in all correspondence with this Board.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Creighton University IRB-02 Social Behavioral's records.

Institutional Review Board
p 402.280.2126 | f 402.280.3200
Dr. C.C. and Mabel L. Criss Health Sciences Complex I
2500 California Plaza Omaha, NE 68178
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creighton.edu/researchservices/rcocommittees/irb