High School STEM Academy Mentor-Mentee Relationships

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The purpose of this study was to examine the mentor/mentee relationships in a high school STEM academy. The research investigated the impact that professionals in the fields of science, technology, engineering, and mathematics have on enhancing STEM education. The goal of the mentor-mentee relationship is to improve STEM skills of the students who are enrolled in the Fairview High School STEM Academy and to enhance their knowledge of the skills necessary to be successful as they enter the workforce or post-secondary education. This particular study focused on the mentors' role in helping high school students to develop the relevant STEM skills.

The results allowed the program evaluation inquiry questions to be fully explored and to provide data on the effects of the relationship. The findings aid in describing the value of the mentor program as a component of the STEM Academy and planning for future mentor-mentee cohorts.

A qualitative approach was used for the program evaluation that was conducted on the high school STEM academy. The data collection methods consist of document analysis, focus groups, and interviews. The qualitative approach was selected due to the low number of participants in the research study and the ability for the research to be based on human observations, experiences, and attitudes about the STEM academy.

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1.0 Introduction

1.1 Problem Area

According to the U.S. Bureau of Labor Statistics, the national projection for STEM (science, technology, engineering, and mathematics) employment will grow by about 13 percent between 2012 and 2022. This is faster than the 11 percent rate of growth projected for all occupations over the decade. By 2020, major American companies will need to add nearly 1.6 million STEM-skilled employees. (Business Roundtable & Change the Equation. 2014). To help fulfill this need, President Obama started the Educate to Innovate initiative of 2009, which calls for expanding STEM education programs, provides "vital signs" toolkits for CEOs," and offers a blueprint for how companies can create quality STEM programs (Business Roundtable & Change the Equation, 2014).

According to the U.S. Department of Education (2015), there is a need for collaborative networks of STEM learning. These networks would be comprised of schools, universities, and business working together to foster skills leading to lifelong learning and opportunities for postsecondary and career success. I am interested in these networks of learning and how they could enhance learning in secondary school students, specifically by focusing on mentoring relationships between corporate professionals and high school students. The mentor-mentee relationship provides opportunities for students to gain a full understanding of the importance and application of STEM and allows for a demonstration of how STEM concepts apply in a work setting (Anderson, Tenebaum, Ramadorai, & Yourick, 2015).

Several government studies consistently emphasize the importance of collaborative STEM programs. The Department of Education found that collaborative networks of STEM learning can foster important skills in all students and lead to lifelong learning and opportunities for post-secondary and career success (*2026*, 2015). The Office of Civil Rights asserts that STEM fields "are gateways to America's continued economic competitiveness and national security" (*Civil Rights Data Collection*, 2014). They also make the case that STEM skills can help to provide employment to underrepresented populations, such as African-Americans, Hispanics, and women, who typically do not gain such opportunities. These networks have positive outcomes beyond academics, as they also pay social, cognitive, and emotional dividends (Scales, et al. 2005). The benefits of collaborative STEM programs among schools and the community are innumerable for all involved.

The Fairview School District has created its own network of learning, the STEM Academy, at Fairview High School. The academy is open for voluntary enrollment for sophomores at Fairview High School. In order to apply to the STEM academy, the sophomores need to have a 3.5 grade point average and pass an interview process with our advisory board. The students, selected to the academy by the STEM advisory board, begin their experience during the spring of their sophomore year. The experience lasts throughout the junior year with expected completion during the fall semester of each student’s senior year, when they begin to apply for college admission or other post-secondary opportunities. During their time in the academy, students take certain coursework at Fairview High School, such as Engineering I, Engineering II, Calculus, and a business course. Additional expectations include completing 10 hours of job shadowing with engineers.

Along with the curriculum offerings, each student works alongside a professional engineering mentor. Mentors serve as resources to provide knowledge and skills that the school curriculum might not otherwise provide. Currently, mentors for the academy currently include engineers from Penelec, LORD Corp, and Grimm Industries. During their time with their mentors, students complete unique engineering and design projects.

Our district's STEM Administrator supervises the entire academy experience. The STEM Administrator is responsible for setting up the business partnerships, selecting mentors, matching mentors with students, and ensuring that students meet their milestones with the projects. The STEM Administrator also serves as the primary contact for the advisory board and reports directly to the Director of Curriculum.

Our STEM Administrator, Ryan Bookhamer, is uniquely qualified for his role. Mr. Bookhamer has integrated his experiences in industry into the classroom at Fairview High School, giving the students real world problems and education from the design and engineering fields.. A job description for the STEM administrator is included in Appendix H.

The companies from which our STEM Administrator recruited offer a variety of experiences for the students, depending on the students' interests. Penelec is a statewide electricity provider in conjunction with First Energy Corp. Their regional headquarters is located in Erie, so their engineers can work in person with our students. For academy students who have an interest in electrical engineering and the power grid, a partnership with this company provides relevant experiences. LORD Corporation is a technology and manufacturing company that started in the coating and adhesives industry and has since expanded to motion management devices and sensing technologies. The majority of their work is done on helicopters and other aeronautical parts. LORD Corp. is a national company that started in Erie but has since moved its headquarters to Raleigh, North Carolina. However, they still have a strong presence in this Pennsylvania region. Lord Corp. offers students exposure to chemical engineering, mechanical engineering, and product development. Finally, Grimm Industries is located near Erie in Fairview and specializes in manufacturing and distribution of innovative plastic-based products, such as Little Tikes toys. Not only can our students learn about the injection molding process at Grimm Industries, they can also study graphic design and marketing.

1.2 Problem of Practice

For my problem of practice, I have created a blueprint (a set of guidelines), a written guide to document the facets of the STEM Academy and the networks, successes, and challenges of this program. This blueprint will illustrate the impact that professionals have on enhancing STEM education. It is my intention to create this blueprint so that other school districts can understand the Fairview High School STEM academy, and, perhaps, replicate it. The blueprint will include how the selection of Academy students, the necessary coursework, information on how we organize the mentoring program, and the benefits and shortcomings of the program after its first year.

Community leaders, politicians, and educators alike have expressed a desire for more effective STEM education in our nation. President Obama echoed the importance of STEM education when he said that he is "committed to moving our country from the middle of the pack in math and science education over the next decade" (Educate to Innovate, 2009). He went on to emphasize the importance of this movement by recognizing that its impact may be bigger than any other factor influencing national job growth. In a study of state-mandated policy on STEM partnerships, one business partner asserted that "STEM is a national issue right now, and we need to position ourselves in the region by doing innovative work in a field that people care about" (Johnson, 2012, p. 46). The need exists nationally and locally to investigate how STEM education can be enhanced by creating partnerships with experts in the field. The blueprint will help to address this need by providing a guide to document the process that Fairview High School went through to develop the STEM academy and to offer documentation to enhance the school-business partnerships that provide students with mentors.

In order to leverage such partnerships, this research focuses on the relationship between high school students and mentors. The bulk of my research will focus on this relationship and provide insight on how this relationship can function to provide a learning experience that our students may not receive in the current traditional school curriculum.

1.3 Inquiry Setting

Erie County, Pennsylvania, is a region in decline but one with great promise. According to a recent article in *The Atlantic*, "The City of Erie was for decades the third-largest city in Pennsylvania, after Philadelphia and Pittsburgh, but its population has fallen from about 140,000 in the 1960s to about 100,000 now, making it fourth largest, after Allentown" (Fallows, 2016). Even with the shrinking population, most experts say Erie County's manufacturing prospects are on the rise. Erie County, Pennsylvania, has a history rooted in manufacturing and industry that dates back to the ship-building factories along the shores of Lake Erie. With this history, the community has a strong industrial infrastructure and a culture of workers that develop, engineer, design, and manufacture new products to create opportunities for its citizens (Fallows, 2016). In order for Erie County to reconnect with its roots and to encourage growth in manufacturing and industry, we can start in our schools.

Fairview School District is approximately 12 miles west of the city center of Erie and approximately four miles west of the Erie International Airport. The district consists of 1,600 students in grades kindergarten through twelve. The economically disadvantaged rate fluctuates between 18 percent and 22 percent, which is by far the lowest in Erie County. The next closest district is Millcreek School District at 41 percent. The Fairview School District is the geographic center of the community, as well as the primary gathering location for families for athletic and social activities. Evidence of achievement and innovation is based on the 2014 National Blue Ribbon Award for Fairview High School (U.S. Department of Education, 2014), its recent distinction as an Apple Distinguished High School (Apple Distinguished Schools, 2017), and the most recent Pennsylvania School Performance Profile score of 101.2, which ranks the district as the second highest performing high school in Pennsylvania (Pennsylvania Department of Education, 2018).

1.4 Stakeholders

Families invest considerable time in the district and take great pride in the education offered. The administrators and the Board of School Directors work together to make educational decisions that are in the best interest of the students and the community. This level of dedication and involvement help to initiate partnerships with local business and industry. The benefits from the partnerships may allow Fairview High School students to be successful in the local workforce and support a local economy. Once a school and a business agree on the meaning of STEM and the skills associated with developing STEM workers, a partnership can begin to form. This partnership can be built around this shared understanding of what STEM means, which allows parties to work together to strengthen STEM skills. It is my belief that a thriving connection between a school and a business will make the STEM academy partnership successful.

1.5 Logic Model

To help explain the organization and goals of the STEM academy, I have included a logic model to help the reader visualize the organization and the flow of the program (see Figure 1). The goal of the mentor-mentee relationship is to increase students' STEM skills and knowledge as they enter the work force or post-secondary education. This particular evaluation focuses on the short-term goal of using the mentor to assist in developing the relevant STEM skills in our students.

1.6 Theory of Action

The theory of action connects the Fairview High School STEM academy, the high school curriculum, and a business partnership that provides mentors. As the mentor-mentee relationships develop, a relevant learning experience evolves to enhance students' STEM skills. The goal is to better prepare students to pursue post-secondary opportunities in STEM fields.

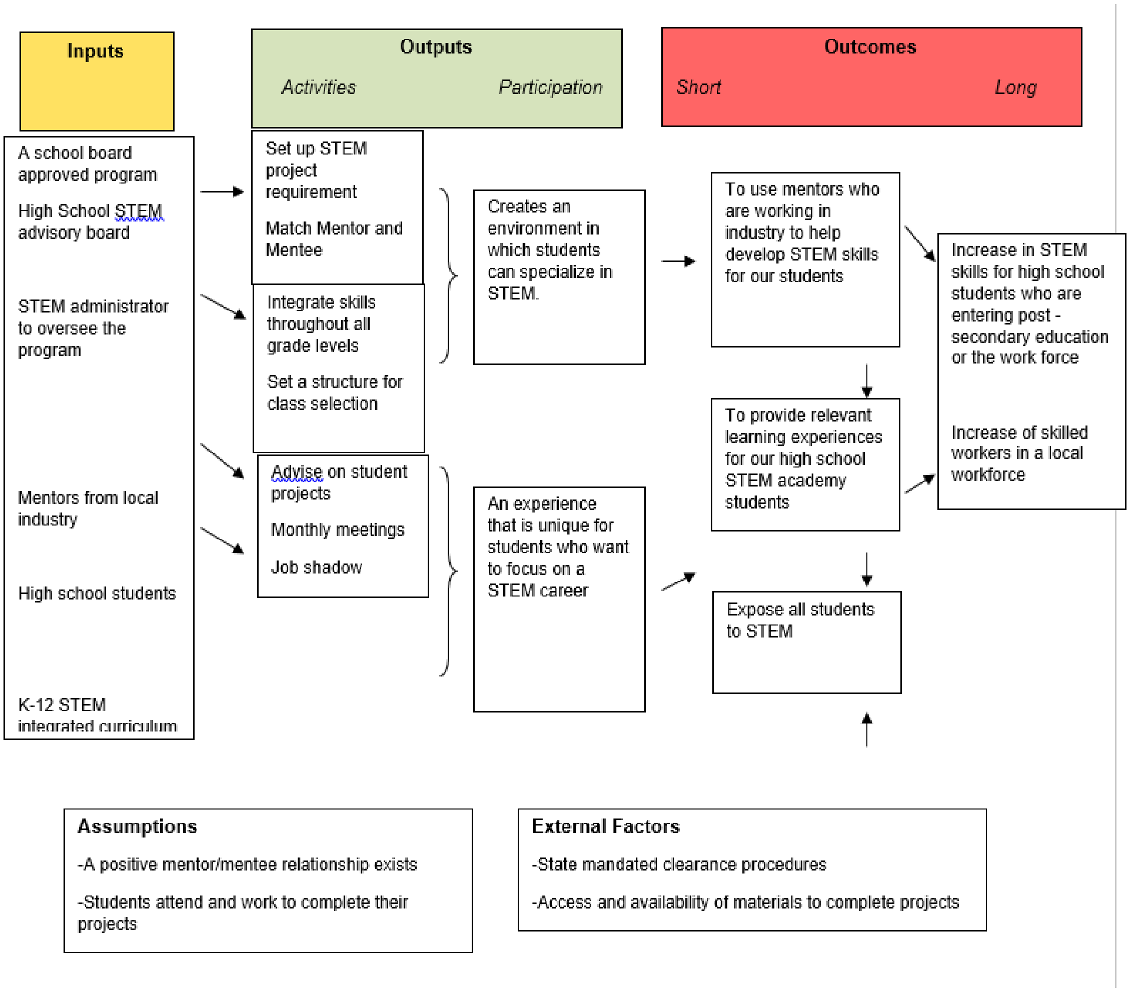

Figure 1. Logic Model: Fairview High School STEM Academy

1.7 Inquiry Questions

1. What elements are needed in a mentor-mentee relationship to enhance the STEM skills that students gain within a STEM academy?
2. Does the mentor-mentee relationship provide an experience that fosters learning so the mentee has an increased knowledge of the skills necessary to be successful in a STEM related career?

2.0 Literature Review

This literature review allows the reader to begin with the background knowledge and rationale for this particular problem of practice. It then includes some common definitions of STEM by various professionals in the field of education and business. The content includes a definition for the term "partnership," along with the identification of facilitating conditions for quality partnerships. The review identifies and analyzes successful partnerships, as well as some unsuccessful partnerships, and consists of both school-business partnerships and school-university partnerships. In addition to identifying partnerships, the review analyzes the presentation of various methodological approaches in past partnership studies and research. Also considered is the role of leadership within a school-business partnership, particularly the role of the principal in partnership outcomes. In addition, the paper explores the role of mentorship programs in enhancing educational offerings.

2.1 Definition of STEM

The acronym STEM, introduced to the American public in 2001 by Judith A. Ramaley, described the National Science Foundation curriculum that incorporated science, technology, engineering, and mathematics (Breiner, Harkness, Johnson, & Koehler, 2012). However, this was not the first suggestion supporting the integration of these topics. Dating as far back as 1902, E.H. Moore addressed the American Mathematical Society:

> Engineers tell us that in the schools algebra is taught in one water-tight component, geometry in another, and physics in another, and that students learn to appreciate (if ever) only very late the absolutely close connection between these different subjects, and then, if he credits the fraternity of teachers with knowing the closeness of this relation, he blames them most heartily for their unaccountably stupid way of teaching him. (Breiner et al. 2012, p.5)

It is with Moore's definition, which indicates a lengthy struggle on the topic, that this paper sets out to address the concept of how we teach these content areas. To understand STEM in the context of a classroom environment, one must determine whether STEM involves a segregated approach to teaching science, technology, engineering, and mathematics, an approach that lacks any integration, as Johnson (2012) suggests. Although some may suggest that STEM provides a meaningful way to integrate science, technology, engineering, and mathematics to solve real-world problems (Labov, Reid, &Yamamato, 2010), Siekmann (2016) suggests that our current definition of STEM is inconsistent and generic. A vague definition of STEM may result in a lack of specific skills necessary to fulfill the occupations that are in demand. Table 1 shows some commonly used definitions for STEM.

Regardless of the definition, many researchers agree that STEM education involves a beneficial instructional approach that moves teachers away from traditional lecture models and into applicable inquiry-based approaches (Breiner et al., 2012). The result of this shift is the emergence of a more integrated-instructional approach that improves creativity and critical thinking in the classroom and produces long-term effects for scientific education and occupations that are in demand. This differs from the traditional science education approach, which calls for an understanding of science and how it can work for citizens (Dillon, 2009). The establishment of

STEM schools in the United States is a growing trend, intended to provide science and mathematics learners an avenue to interact with university faculty and professionals in the field early in their educational experience (Tan & Leong, 2014). By having a clear definition of the term STEM and the skills associated with STEM education, the current study can provide a shared language for businesses and educational institutions. This common language will allow the school district and the business to form a partnership that may enhance the quality of education in the school district and provide the business with sought after benefits. Table 1 provides some established definitions of STEM.

Table 1. Common Definitions of STEM

Author	**Definition**
National Science Foundation (2001)	A traditional approach to teaching science, technology, engineering, mathematics in a segregated fashion
Labov, Reid, and Yamamoto (2010)	The purposeful integration of the various disciplines of science, technology, engineering, and mathematics
Siekmann (2016)	An acronym that refers to the disciplines or subjects of technology, science, mathematics, and engineering, taught and applied either in a traditional setting and discipline-specific manner or through a multidisciplinary, interconnected, and integrative approach
Aschbacher, Li, and Roth (2010)	Biological, environmental, physical, and medical sciences as well as engineering, information technology, and mathematics
North Carolina Board of Education (2016)	Student-centered approaches to instruction
Tsupros, Kohler, and Hallinen (2009)	A curricular approach that integrates science, technology, engineering, and mathematics disciplines and connects them to real- world experiences

2.2 Defining Partnerships

Once a school and a business agree on the meaning of STEM and the skills associated with developing STEM workers, a partnership can begin. It is my hypothesis that a thriving connection between a high school student mentee and a business or university professional mentor will make the STEM partnership successful. In order to support this theory, a thorough evaluation of partnerships must occur. Kingsley and Waschak (2005) explored various definitions of partnerships, since one of the challenges of studying a partnership is the lack of understanding of the term. They provided definitions for partnerships based on the sector that was trying to describe the term. For example, the organizational sector defines a partnership as one that includes the exchange of knowledge and technical skills to secure position within an organization (Oliver, 1990). The outcome of this partnership finds its basis in the strategic questions of understanding how people form the partnership.

In contrast, Osborne (2000) defines public management partnership as a remedy for different movements to address reform agendas. These generally include evaluations to monitor outcomes. The third sector is education; Kingsley and Waschak (2005) focus on the school-university partnership, which creates networks of communities to enhance programs and activities. The school-university partnership is comparable to a school-business relationship (Kingsley et. al. 2005). The primary goal of a school-business partnership is to improve programming and knowledge so that both parties benefit. Analyzing how the school-university and the school-business partnerships have operated in various education settings will provide some understanding of how best to create partnerships with Fairview High School. While the scope of this study and literature review is on school-business relationships, there are lessons to be learned about successful mentoring from university-school partnerships. The following subsections offer some insight into school-university and school-business partnerships.

2.2.1 School-University Partnerships

Bissaker (2014) examined a partnership at the Australian Science and Mathematics School (ASMS), an institution for mathematics and science instruction for high school seniors. ASMS is an inclusive STEM school on the campus of Flinders University in South Australia. The school was designed in part to address declining enrollment in mathematics and science courses across the country. Contributing factors included student attitudes, the lack of a contemporary curriculum, and the dearth of qualified STEM teachers. This partnership pairs the faculty and students of the secondary school with university faculty.

The purpose of Bissaker's work was to examine the documents and processes that led to re-energizing this school and reinvigorating the staff members. The main factors Bissaker examined were the curriculum frameworks of the mathematics and science programs, along with professional development provided for the staff members. The curriculum work focused on three key areas: the introduction of relevant science topics, the connections between science and other disciplines, and the introduction of inquiry-based learning.

Professional development included weekly curriculum meetings and university module courses. University module courses consisted of 100-minute lectures on topics, such as robotics and cryptography, provided by the university and presented to the school faculty and students. By understanding the steps in curriculum development and professional development that led to the re-energizing of the program, educators and administrators gain some knowledge of what to look for with successful programs. Bissaker discovered that the school thrived based on the quality relationships between the faculty of the school and the professors at the university. Both groups were working toward a shared vision to develop an innovative interdisciplinary curriculum.

2.2.2 School-Business Partnerships

Sanders (2001) described partnerships as "connections between business and schools that are forged to promote students' social, emotional, physical, and intellectual development" (p. 1346). According to Lee, Hope, and Abdulghani (2016), these types of partnerships bring about authentic learning experiences while creating positive student attitudes and discipline. The business benefits by representing itself in a positive light with the public, while promoting its image by building community. According to Scales et al. (2005), students exposed to school-business partnerships earn better grades, have better school attendance, and are motivated to do well academically. If implemented well, partnerships span out from the school and business to produce benefits within the community. A school-business partnership may consist of industry, museum, an institute of learning, or any other type of organization that has workers who can work with students.

According to Sanders (2001), partnerships provide direct services such as incentives, scholarships, job shadowing, tutoring, and other career opportunities. The ultimate goal for both the business and the school is to develop a workforce that is qualified to apply twenty-first century work skills in the workplace. A number of studies focusing on specific school-business STEM partnerships shed light on the various benefits and pitfalls of school-university relationships, including the following three examples.

2.2.2.1 W. R. Grace-Atholton Educational Partnership

Blake and Pfeifer (1993) conducted a study to determine if the partnership between W.R. Grace-Atholton High School staff and students and the employees of the Washington Research Center had a significant impact on children's education. The W.R. Grace-Atholton Educational Partnership takes place in urban areas in Maryland. The researchers reviewed the documents used to establish and sustain the program and tracked statistics, including science enrollment, SAT scores, and the ratio of computers to students. The documents associated with Atholton High School show some successful steps on how to start a partnership, such as creating a position to support the work, providing initial training to staff members, and successfully kicking off the partnership. It is critical to have practices in place to maintain the partnership, such as creating committees that regularly meet and work with leaders in each business. By analyzing the evaluation methods used, such as the one in Atholton High School, our district can assess the performance of our partnership. The Atholton Educational Partnership displays the importance of buy-in from top-level administrators in the district and the business. This review will return later to the importance of school leadership in a successful partnership.

2.2.2.2 Houston Independent School District Partnerships

Scales et al. (2005) set out to study the connection between students' attainment of developmental assets and school-business partnerships. The researchers define developmental assets as a collection of skills, opportunities, values, and relationships that are necessary to produce responsible and productive individuals. To gather data, the researchers surveyed families whose children attended an inner-city high school in Houston, Texas.

In related research, a team from Harvard University visited a school in Houston Independent School District to perform face-to-face interviews with students in order to study the effects of school-business partnerships. One established partnership within this particular high school was Project GRAD. The goal of Project GRAD is “to ensure quality public education for all children in economically disadvantaged communities” (Scales et al., 2005). Other partnerships within the high school include ArtworkZ through the Museum of Cultural Arts, the Cisco Networking Academy Program, Hotel and Restaurant Management Magnet Program, and the Pregnancy Education and Parenting Program. Collecting data on these various partnerships provided insight on successes and failures of the partnerships that existed in Houston Independent School District.

Harvard’s findings show that the partnerships had a positive impact on student learning. Sixty percent of the students showed improvement in reading, writing, and math skills. The results also show greater responsibility, creativity, and problem-solving capability among students. The number of graduates in the partnership programs at the school increased from 235 in 1993 to 308 in 2003. During this time, enrollment remained consistent. Lastly, the students in the partnership were far more likely to discuss college plans with their parents than the students not enrolled in a partnership. All of these findings indicate that the partnership has a positive impact on outcomes for the high school students.

2.2.2.3 North Carolina Inclusive STEM High Schools (ISHS)

Means, Wang, Young, Peters, and Lynch (2016) examined the impact of inclusive STEM high schools (ISHS) in the state of North Carolina. The inclusive STEM high school (ISHS) has a focus on STEM education and forgoes the traditional high school model. The inclusive STEM high schools have a student application process to ensure the students are interested in STEM education. In this particular study, the researchers defined an ISHS as having selective admissions and an intensive STEM experience for all of their students. Further experiences for these inclusive STEM high schools consist of activities outside the school day that allow students to make connections with professionals in a STEM field. The study set out to compare the likelihood of students attending these inclusive STEM high schools taking higher-level math classes and showing a keen interest in a STEM-related career. Researchers analyzed statewide data, along with study surveys.

One primary finding was that the North Carolina inclusive STEM high schools are serving a greater population of underrepresented students, including African-Americans, Hispanics, and women. Also, the study showed that graduates of the inclusive schools are 90 percent more likely to be connected to professionals in their mentors' fields, in contrast to 67 percent in a non-STEM school. Moreover, the ISHS twelfth graders are more likely to take courses such as chemistry and calculus. ISHS students also are more engaged with STEM extracurricular activities and more likely to focus on a science career. The findings show the value that an education focused on STEM has for underrepresented populations.

W. R Grace Atholton, Houston Independent Schools, and the North Carolina ISHS all provide examples of larger urban school districts collaborating with local businesses. In the three cases, the investigators highlighted successful models. The following will provide some insight into a failing school-business partnership. Learning from the failing partnerships is critical to avoid the same flaws when secondary schools work to create partnerships with businesses.

2.3 A Failing Partnership

Not all STEM partnerships result in success. Taylor's (2000) case study demonstrates the demise of a school-business partnership in Alberta, Canada. This particular study involved Academic High (pseudonym), whose demographics are similar to those of Fairview School District, and Monarch Oil and Gas Corporation. The partnership began in 1989 and dissolved in 1998. The interview process in this instance provided data from the perspective of individuals affected by the demise, including the high school principal, the guidance counselor, the partnership leader, school council members, and a representative from the Partnership Foundation. This partnership is different from the others identified in this review since it was part of the educational reform that Alberta was undergoing in the early1990s and was thought to be an intervention for education. Therefore, the Calgary Board of Education showed a keen interest in this particular area. The Calgary Board of Education started the Partnerships in Education program, along with a Partnership Foundation, the latter consisting of businesses, school leaders, a board of directors, and other educational stakeholders.

One observation about the demise came from the principal of Academic High, who viewed the system as "top down." The principal stated that decisions came from the Chamber of Commerce and the Board of Directors. This system lacks the structure of the other successful partnerships, such as Atholton High School, which had teacher buy-in. Another obstacle occurred when Monarch received some negative press with connection to the Apartheid regime in South Africa. Next came public comments by two articulate and well-respected department heads who questioned the involvement of businesses in schools. Monarch employees, in turn, questioned these teachers on specific content they were teaching. These instances demonstrate the teacher unrest that ultimately led to the downfall of the partnership. Academic High represents a failing partnership because teachers were not valued in the process and therefore did not support the program.

2.4 Principal as a Catalyst for Success

In all of the successful partnerships presented in this literature review, one factor they have in common is a strong principal. As Sanders and Harvey (2002) studied the value of the principal as a catalyst in effective school-community collaborations, they sought out all partnerships the school had, which included those with businesses, civic organizations, health care institutions, and parents. During a series of interviews with the members of the partnership, the authors gathered perspectives on the initiation process of the partnership, the development of the relationship, and the outcome of the partnership. The interviews provided data from all stakeholders. The principals in Sanders's and Harvey's case-study school approached the partnership as a triad of entities with the school, the parents, and the community. This case study is unique in that there was principal change during the period of study. Both principals were successful in their approach, so comparing their philosophies is important. When interviewed, the new principal valued the program's parent involvement more than the community involvement. The former principal, who was not as successful with building community involvement, viewed the partnership with the parents and the community as equal. In both approaches, the leaders chose to use the parent and community involvement to their advantage to create open and collaborative environments. They both valued the partnership as critical to their success and the students' education.

2.5 STEM Partnership: Mentoring Experience Between Student and Industry Mentor

There has always been a long tradition of societies nurturing and preparing the next generation of craftsmen and workers through internships, apprenticeships, and formal guilds. The primary goal is to ensure that young people acquire skills and knowledge that will help them in finding meaningful and fulfilling vocations. Also, such initiatives provide opportunities for young people to learn from mentors. By intentionally and carefully educating and guiding young people to develop and find rewarding vocations, communities and nations have managed to ensure a stable and robust social foundation. Furthermore, such countries can ensure a constant stream of young men and women who can support the economic and social development of the society. These benefits can be realized in STEM programs to help students acquire relevant skills and knowledge required to succeed in their professional endeavors.

A review of the research reveals the importance of mentor-mentee relationships in STEM programs. According to Anderson, Tenenbaum, Ramadorai, and Yourick (2015), mentor-mentee relationships provide opportunities for students in to gain a full understanding of the importance and application of mathematics, science, technology, and engineering. In particular, such a relationship gives mentors the opportunity to demonstrate how the concepts that students learn in class will apply to the work setting.

Tenenbaum, Ramadorai, and Yourick (2015) carried out a qualitative study to explore the significance of STEM partnerships using a sample population of 43 mentors and 1,328 students. In this case, both the mentors and students reported benefits, challenges, and opportunities associated with STEM partnerships. The researchers indicated that STEM partnerships help students to acquire new skills and knowledge from mentors. Besides, they act as an efficient and reliable model for promoting and supporting career development. Finally, the researchers argued that STEM partnerships support the health and well-being of students and support the acquisition of professional behaviors by learners. In the long run, the programs ensure that students are better situated to use skills in engineering, science, mathematics, and technology in the work setting.

Previous studies have highlighted mentor-mentee programs. One such program is the Institute for STEM Teaching and Research at Northwestern University (iSTAR@NU) (Northwestern University School of Education & Social Policy, 2017). This particular program is for middle and high school teachers. It strives to improve the skills and abilities of students through lab experiments, computer loaner programs, and curricular development. Furthermore, it uses online resources to provide opportunities for students to interact with their mentors in real time. Northwestern University School of Education & Social Policy (2017) noted that the iSTAR@NU is a STEM partnership program that strives to improve and support student and teacher professional development, enhance science and technology standards, and emphasize the mastery and application of content across. In addition, the initiatives emphasize learning through better decision making, developing 21st-century capabilities and skills, and preparing young students to become people who can contribute to the development of global economy and society (Northwestern University School of Education & Social Policy, 2017). Every year, STEM partnership programs such as iSTAR@NU create a broad range of symposia, workshops, and courses for learners and teachers (Northwestern University School of Education & Social Policy, 2017). The successful implementations of such initiatives facilitate the sharing of knowledge on best practices, promote collaboration, and develop students to become better engineers and scientists (Northwestern University School of Education & Social Policy, 2017).

STEM partnership programs can take various forms and models depending on the needs of students and the short-term and long-term goals of the initiatives (Crisp, 2009; Kostovich & Thurn, 2013; Marshall, 2010; Wilson et al., 2012). In particular, the programs can take the form of a student working with external mentors on a specific subject, or multiple students working in research and study groups under the guidance of a mentor (Crisp, 2009; Kostovich & Thurn, 2013; Wilson et al., 2012). In other cases, learners can be part of apprenticeship programs led by faculty mentors or experts in a particular area of interest, such as engineering (Feldman et al., 2013; Vandermaas-Peeler, Miller, & Peeples, 2015; Vandermaas-Peeler, Nelson, Ferretti, & Finn, 2011). Vandermaas-Peeler (2016), however, noted that the apprenticeship model is one of the most commonly used approaches in STEM programs. The researcher noted this particular model relies on a social and developmental constructivist theoretical approach to teaching and learning. Students get an opportunity to learn and acquire new knowledge through sustained and engaging collaborative participation in authentic activities and programs. Through the mentorship programs, students become part and parcel of the inclusive, scholarly, and knowledge building groups and communities (Hagstrom, Baker, & Agan, 2009; Kostovich & Thurn, 2013; Wilson et al., 2012). In addition, the apprenticeship programs introduce learners to research practice through the expertise and guidance of mentors and experienced peers. In the end, students transition from being newcomers in the academic communities to people with significant professional identities and capabilities (Kostovich & Thurn, 2013; Vandermaas-Peeler, 2013; Wilson et al., 2012).

Hunter et al. (2007) conducted a longitudinal study to examine the role and significance of student participation in STEM mentorship programs with particular emphasis on professional and personal development. The researchers interviewed participants to gather information on the views of students and faculty members on the significance of mentorship programs (Hunter et al., 2007). The data showed that both students and faculty members understand and appreciate the significance of mentorship programs. However, faculty members were more likely to consider development and mentorship programs as a part of the journey to becoming engineers and scientists (Hunter et al., 2007). Students, on the other hand, view the programs as vital tools that can support their personal growth. Camacho et al. (2015), assessed the significance of mentorship with collaborative learning communities in which students get an opportunity to learn from peers and mentors. In particular, the researcher noted that the programs provide vital learning opportunities and foster the creation of a learning environment that promotes the sharing of knowledge and ideas (Camacho et al., 2015). Consequently, mentoring programs should be part of initiatives meant to improve the performance of students in sciences, technology, engineering, and mathematics (Camacho et al., 2015; Shanahan et al., 2015).

2.6 Review

Implementing a STEM school within the structure of a traditional high school can be an effective program change for districts looking to establish a program that supports students learning outside of the classroom. The alternative may be to open up a new building dedicated to STEM education and have an application process so students compete to enter the school. The evidence from W.R. Grace Atholton, Houston Independent School District, and the North Carolina ISHS suggests that quality partnerships do exist and rely upon many factors to make the programming useful. It is my goal to highlight the significance of strong partnerships and a supportive mentor-mentee relationship that enhances STEM education. The long-term outcome of such programming is an enhanced local curriculum in a public high school that helps to provide skilled workers or college-ready graduates.

STEM schools can provide districts the opportunity to help generate the 1.6 million STEM-skilled employees that will be needed by 2020. However, the possibility of districts opening new buildings devoted strictly to STEM education is unrealistic in most cases. A blueprint for school districts to show the successes, obstacles, and benefits of establishing a STEM program within an existing high school is critical to boosting the workforce in Erie County and nationally. To complete that blueprint, the following questions need to be answered: What is our definition of STEM, and how does the Fairview School District prioritize the study of STEM skills? How does a suburban public school work to build quality partnerships so that both parties benefit? What is the formula for creating an exclusive STEM school within the walls of an already established, fully operating public high school? How does a successful mentor-mentee program enhance the education process?

3.0 Inquiry Design

3.1 Methods and Evidence

A qualitative approach was used for the program evaluation I conducted on the high school STEM academy. The data collecting methods consist of document analysis, focus groups, and interviews. Since these data collection methods for the program evaluation are a part of my job duties at the Fairview School District, I did not have to get IRB approval for the evaluation. Documentation of my inquiry with the IRB is attached in Appendix D.

The qualitative approach was selected due to the low number of participants in the research study and the ability for the research to be based on human observations, experiences, and attitudes about the STEM academy. The qualitative analysis will provide the answers to my following inquiry questions. What elements need to be present in a mentor-mentee relationship to enhance the STEM skills that students gain in a STEM academy? Does the mentor-mentee relationship provide an experience that fosters learning for the mentee so that the mentee has an increased awareness of the skills necessary to be successful in a STEM-related career?

3.1.1 Document Analysis

The documents to be analyzed in this program evaluation are the student log sheets. The log sheets are provided to all student participants in the STEM academy. Each of the 12 students in the academy fills out the log sheets electronically in order to accurately document their meetings with the mentor. A sample log sheet is found in Appendix A. On the log sheet, the student records the date of the meeting with the mentor, the time, a description of the activities during the meeting, how the meeting moved them toward their goals, and a plan for the next meeting. The log sheet provides insight into the types of experiences that mentors and mentees have within the STEM academy. Those experiences will be analyzed based on frequency of meetings; types and format of meetings; and whether they are face-to-face, virtually live, or via electronic communication. The analysis of the log sheets will allow the researcher to gain insight into the events that take place between the mentor and mentee. Alternatively, the log sheet can provide the researcher with some knowledge of what types of experiences are missing from the program that affect the intended outcome of creating an experience that will better prepare the students for their post-secondary lives. The document analysis will answer inquiry question one so that the researcher may understand the experiences that enhance the mentor and mentee experience.

3.1.2 Focus Groups

Two focus groups were held for students in the STEM academy. The students were randomly divided into two groups of five to seven students each. The first focus group was held on April 19, 2017 and the second one was held on May 25, 2018. The focus group method was selected for the high school students since the participants tend to be influenced by one another, and the contributions to the discussion will be greatly affected (Oliveira & Popjoy, 1998). Focus groups tend to be less threatening to many participants, and this environment is helpful for participants to discuss perceptions, ideas, and thoughts (Krueger & Casey, 2000). This format will assist in providing accurate feedback since the person holding the focus group is an adult and an authority figure. The intent is for students to feel comfortable being honest about the process and not providing answers they think the adult wants to hear. The data gathered from the focus groups will provide information to address the portion of inquiry question 1 that is looking for specific mentor and mentee experiences in the program. The focus group will also provide answers to inquiry question 2 so the researcher can gain insight on the STEM skills that were enhanced during the academy experience.

3.1.3 Interviews

Interviews were conducted with the seven mentors who work at LORD Corporation, Grimm Industries, or Penelec. Due to the low number of volunteers and the ability to take a more personal approach, interviewing the mentors allowed for an informal discussion that would allow the mentors to tell their stories about the experience. Interviewing provides a necessary avenue of inquiry in the educational settings (Seidman, 2006). The interviews conducted are to gain insight on the students and mentors experience with the STEM academy. The interviews conducted were standardized, open-ended interviews that used the same questions for all participants (Seidman, 2006). The interviews consisted of nine questions, and all responses were recorded using a mobile device so that transcribing could easily occur and the interviewer did not spend the time logging answers. See the interview questions in Appendix 3.

3.2 Analysis and Interpretation

Document analysis consisted of coding and analyzing the log sheets that students completed. The log sheets were coded for the number of meetings, the types of activities that took place, whether the meetings moved students toward their goals, and whether plans were created for the next meeting. In addition, the total amount of time the meetings take up was documented. This data was analyzed in order to address inquiry Question #1: What elements need to be present in a mentor-mentee relationship to enhance the STEM skills that students gain with the STEM academy?"

The coding and analysis strategy followed the codifying and categorizing process that Saldana suggests in his *Coding Manual for Qualitative Researchers (2015).* This process allowed for major themes to develop as I categorized and classified the data in an Excel sheet. I was able to summarize the data into themes that developed and established a clear logic model toward quality experiences. The qualitative data was also coded to quantify the number of meetings between the mentor and mentee and the amount of time spent during the meetings. This qualitative analysis will allow for an explanation of how the daily log reflected the impact on the STEM academy experience.

Focus group responses were audio recorded via an iPad and later inductively coded to allow for interpretation and summarization. Observations were noted during the focus group to allow for documentation of any physical reaction that may be valuable during data analysis. After each focus group, discussions were transcribed using www.rev.com (a transcription service provider) and coded in Excel. The focus questions can be found in Appendix B.

The information from the focus groups was used for evaluating various aspects of the mentoring relationships that are created. The group response will allow for analyses of the strengths and weaknesses of the mentoring relationships in order to improve the collaboration process. Upon analyzing responses, data will be summarized on aspects of the partnerships, such as benefits, drawbacks, participant satisfaction, and curriculum enhancement. This information will allow the researcher to address inquiry Question #2: Does the mentor-mentee relationship provide an experience that fosters learning for the mentee so the mentee has an increased awareness of the skills necessary to be successful in a STEM related career?

The seven interviews with the mentors will provide insight into the mentoring. Along with the log sheets, the interview results will help to document the mentor experience. The mentors are significant contributors to the experience the students get in the STEM academy. The interviews will provide further insight into the experiences the mentor was able to provide, the frequency of the meetings, and the depth of conversation during those meetings. The interviews will also be transcribed using www.rev.com and coded in Excel. The interview questions are found in Appendix 3 This information was used to explore how and if learning was enhanced, but the interview focused primarily on the learning and benefits that the mentor gained during this experience. The interviews also assisted in addressing inquiry question #2. A summary of the methods and how they relate to each inquiry question can be found in Table 2 below.

The coded data from the log sheets, the focus group responses, and the interviews were coded in Excel.

Table 2. Summary of Methods

<table>
<tr><td colspan="3">Inquiry Question #1
What elements need to be present in a mentor-mentee relationship to enhance the STEM skills that students gain within a STEM academy?</td></tr>
<tr><td>Evidence</td><td>Design Method</td><td>Analysis and Interpretation</td></tr>
<tr><td>Mentee Log Sheets</td><td>Document Analysis</td><td>Coding and categorizing of experiences that influence learning
Common themes and experiences were coded and organized in Excel</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">Inquiry Question #2
Does the mentor-mentee relationship provide an experience that fosters learning for the mentee so the mentee has an increased awareness of the skills necessary to be successful in a STEM related career?</td></tr>
<tr><td>Evidence</td><td>Design Method</td><td>Analysis and Interpretation</td></tr>
<tr><td>2 Mentee Focus Groups of 5-7 students each</td><td>Focus Group</td><td>Coding and categorizing of recorded audio took place
Themes and experiences were coded and organized in Excel</td></tr>
<tr><td colspan="3"></td></tr>
</table>

Table 2 continued

Evidence	Design Method	Analysis and Interpretation
Six mentor interviews	Interview	Interviews provided insight on how the interactions with the mentor benefited the student's experience. Coding and categorizing the interview data to interpret themes and activities that are presented to support learning

3.3 Proposed Demonstration of Scholarly Practice

The product for my problem of practice will be a blueprint, or "how-to guide," for school and business leaders to guide their integration of STEM in a high school curriculum. Ideally, this blueprint will be transferrable across various types of school and business settings that leaders can reference in order to support a culture shift in which the knowledge of business professionals enhances the knowledge that teachers present in the classroom. The primary focus of the blueprint will be a thorough analysis of the mentor-mentee relationship and the aspects needed to make the relationship successful. The result can be an enhanced curriculum in which students are better prepared to enter a workforce that is calling for 1.6 million STEM related jobs by 2020 (Business Roundtable & Change the Equation. 2014). In order to meet this need, it is my belief that we cannot just have STEM classes in the high school; instead we need to have a cultural shift so that STEM will be integrated into all aspects of education.

Within the blueprint, I have established a set of guidelines that identify the successes of year one of our STEM academy, along with areas that are changed for year 2. These guidelines will be based on the feedback obtained through mentor and mentee interactions. The roles of the STEM administrator and the mentors from business will be defined in order to understand how each entity can contribute to the student experience. These suggested guidelines are made to better inform leaders on successful practices that were established to enhance our STEM academy and create their own STEM network.

4.0 Findings

The purpose of this study was to examine the mentor/mentee relationships in a high school STEM academy. Therefore, the research investigated the impact that professionals in the fields of science, technology, engineering, and mathematics have on enhancing STEM education. The goal of the mentor-mentee relationship is to increase STEM skills of the students who are enrolled in the Fairview High School STEM Academy and to increase their knowledge of the skills necessary to be successful as they enter the workforce or post-secondary education. This particular study focused on the mentors' role in helping high school students to develop the relevant STEM skills.

Prior research indicates that the relationship between the mentee and the mentor offers a suitable learning platform for STEM students. This relationship also gives students the experience that is needed in STEM careers (Marshall, 2010).

Qualitative data analysis in the form of document analysis, focus groups with students, and one-on-one interviews with mentors, was performed to address the following inquiry questions: What elements are needed in a mentee-mentor relationship? Does the mentee-mentor relationship provide an experience that fosters learning?

The results allowed the program evaluation inquiry questions to be fully explored and to provide data on the effects of the relationship. The findings aid in describing the value of having the mentor program as a component of the STEM Academy and planning for future mentor-mentee cohorts.

4.1 Summary of Findings by Inquiry Question

To provide the reader with a better understanding of the findings, a summary of each inquiry question addressed in the analysis is provided below. Following the analysis of data, interpretive findings are reported.

4.1.1 What Elements are Needed in a Mentee-Mentor Relationship?

The researcher found that certain elements of the mentor-mentee relationship, such as more time, more structure, and allowing students to solve their own problems by asking questions and building resilient learners, were the most frequent responses when participants were asked about the elements needed for success in the relationship.

4.1.1.1 More Time

Table 3. The coding and categorization and how time affects the mentor-mentee relationship

Method	Note	Category 1	Category 2
Focus Group	The independent study helped set time aside for mentor	Relationship	Time
Focus Group	The independent study helped me be a little more structured	Structure	Time
Focus Group	The independent study helped me focus a bit more and give time to the project	Relationship	Time
Interview	Scheduling and timing	Area for improvement	Time
Interview	Time is a challenge of the program	Challenges of program	Time
Interview	Mentor's role in developing skills is limited due to time	Skill to develop	Time
Interview	Making a schedule work is a challenge	Challenges of program	Time
Interview	Need to have one meeting a month at least	Area of improvement	Time

Table 3 continued

Interview	Constraints of accessing students	Limits to the program	Time
Interview	The independent study in spring created a time to meet	Meeting	Time

The element of time was identified by three (36 percent) students during focus groups and by six (75 percent) interview participants. The focus group students specifically identified time as a critical element during their independent study. When the three students had this time set aside during their school day, they were able to progress through their projects and dedicate the time to setting up communication with their mentors. These three particular students are juggling AP courses, athletics, and friendships, so being enrolled in independent study provided valuable time to focus on their projects. The mentors spoke about the challenge of time and only having one meeting a month to offer input. One mentor stated that, "The time for me was a constraint in building the relationship I desired; my access to the student was limited." This mentor, who oversees production and is involved with the sale of Little Tykes toys, sought more time with his mentee.

Time is required to define goals, seek out advice, cultivate relationships, and attend meetings; it requires a commitment of time to build a strong network of mentors, which culminates in stronger bonds to be used in navigating more complex discussions in the future within the STEM field. Therefore, more time is needed to have meaningful conversations that make the most of the students' strengths, taking into account their current constraints and generating sets of possibilities to make them better people (Marshall, 2010).

4.1.1.2 More Structure

Table 4. The coding and categorization on how the structure of a program affects mentor-mentee relationship

Method	Note	Category 1	Category 2
Interview	Need for more structure	Area of improvement	More Structure
Interview	Overall structure needs improved	Area of improvement	More structure
Interview	Add milestones to the project to make it more structured	Area of improvement	More structure
Interview	Suggested a guide for volunteering	Area of Improvement	More structure
Interview	Provide more structure	Area of improvement	More structure
Interview	Need for more structure	Challenges of program	More Structure
Interview	Add milestones to the structure	Area of improvement	More Structure
Interview	Have expectation sheet	Area for improvement	More Structure
Focus Group	A better timeline would help the relationship develop	Relationship	More Structure
Focus Group	More structure would allow for more time with the mentor	Relationship	More Structure

Structure emerged as an area of improvement in both student focus groups. For instance, one student identified the overall structure of the timeline and milestones as an area of improvement. Another student connected time and structure and speculated that more structure in the program could lead to more time with the mentor.

The concept of better program structure was mentioned in five (63 percent) of the mentor interviews. The mentors were looking for specific expectations to guide their work, a clearer definition of milestones, and a clearer vision for the end product. One mentor, who is a serving in management at LORD Corporation, mentioned that he would "get eaten up in his work environment if he was not able to answer the questions; what are we were expecting to accomplish next week? Next month? Or the next three months?"

Mentor and mentee feedback indicated that a more structured program could allow students more time with the mentors, thereby enhancing the effectiveness of the program. This idea was mentioned by two (29 percent) of the students. One mentor made the connection of creating a timeline of milestones that would allow for a better structure to the overall experience.

4.1.1.3 A Mentor Who Is Going to Ask Questions and Allow the Students to Build Resiliency

Table 5. The coding and categorization on how problem solving and failure affect mentor- mentee relationships

Method	Note	Category 1	Category 2
Interview	Made mentee ask questions	Skill	Problems solving
Interview	Provide problem solving opportunities	Skill	Problem solving
Interview	Helped break a problem down, problem solving	Skill	Problem solving
Interview	Encouraged them to have the initiative to find information	Skill	Problem solving
Interview	Able to get mentee thinking and ask questions	Skill to develop	Problem solving
Interview	Allows students to create with their own hands	Skill	Problem solving
Interview	Brainstorming ideas is something I used to do early in my career, I got away from it, this allows me to do the same	Skill	Problem solving
Interview	Questioning student to help lead them to the answer	Skill	Problem solving
Focus Group	Asked a lot of questions to help develop my project; I wouldn't have asked these	Relationship/Skill	Problem solving
Focus Group	My mentor was critical for me but it helped me stay on task when I knew a meeting was coming up.	Relationship	Problem solving
Focus Group	We were allowed to explore our own ideas	Development of product	Problem solving
Focus Group	Mentor made me push through things and come up with different ideas	Skill	Problem solving
Focus Group	Helped with problem solving skills, how to get started, how to solve problems	Skill	Problem solving
Interview	Students can make mistakes	Skill	Resilient

Table 5 continued

Interview	Can learn from failure	Skill	Resilient
Interview	Helps student discover solution	Skill	Resilient
Interview	Told them to experience failure	Skill	Resilient
Interview	Give them the opportunity to fail	Skill	Resilient
Interview	Kids are afraid of failure they should be ok with failing so be used to a failure	Effort in kids	Resilient

In 19 of the coded responses to the focus group and interview questions, mentors or mentees identified the problem-solving process as a critical element in a mentor-mentee relationship. Along with problem-solving, the data revealed that students became resilient when they were asked to rethink and redesign their ideas during the design process. Building this resiliency as an element of learning is an important quality in the mentor-mentee relationship. Resilience is defined as a dynamic process that encompasses positive adaptation with the context of adversity (Luther, Chicchetti, and Bronwyn (2000). In eight (100 percent) of the interview responses, mentors identified the ability to ask students questions to further their thinking, encourage them to find answers, and question the product results as a way to enhance student problem-solving skills. One mentor stated that his mentee was overwhelmed in the beginning of this experience. The mentee was not sure how to get his idea to a physical product, but watching him develop and work through the problem and figure things out on his own was enjoyable. Eventually, this student, who was trying to develop an electrical automated ratchet strap, was able to prototype his idea. Similarly, mentees stated that when their mentors were critical of their work, they did not provide answers but instead forced students to think through the problem, allowing them to think creatively. As the mentees were being forced to solve their own problems, the mentors were forcing the students to accept criticism and move on to create better solutions. One mentee, who was trying to develop fogless swim goggles, was forced to redevelop her prototype by using five different plastics, all while trying to learn how those plastic conduct heat differently.

Five of the mentees, or 71 percent, identified this process of building resilience as an important element in the mentor-mentee relationship. It is important that a mentor ask questions and allow mentees to experience adversity in order to develop their skills. Giving the students the opportunity to face adversity, and in some cases fail, provides them with an important learning experience (Marshall, 2010).

4.1.2 Does the Mentee-Mentor Relationship Provide an Experience That Fosters Learning?

The second inquiry question attempts to determine whether the mentor-mentee relationship is effective in providing experiences that foster learning, so the mentee has increased knowledge of the skills necessary to be successful in a STEM-related career. The questions in the interviews and focus groups were framed so that answers to this inquiry question were provided by both mentees and mentors. According to the qualitative analysis and the coding and categorizing of the data, mentors and mentees identified the following areas as components of their experience that fostered learning: allowing them to solve problems through the design process; forcing them to think about the end user, budgeting, and marketing; and providing real-world experience. See Table 6 for a summary of the results for the second inquiry question.

4.1.2.1 Allows the Mentee to Solve Problems Through the Design Process

Table 6. The coding and categorization for how problem solving through the designing process fosters learning

Method	Note	Category 1	Category 2
Interview	Design process	Skill to develop	Design
Interview	Helped with the design process	Skill	Design

Table 6 continued

Focus Group	Helped me think about the internal components	Quality of product	Design
Focus Group	Mentor helped with design process	Skill	Design

The design processes were identified as necessary experiences to foster learning. Table 6 shows the responses by the mentor and mentee in regard to the design process. One student asserted that the mentor was critical throughout the process, in a constructive manner, and in the end provided a unique learning experience that the student had not previously experienced in the classroom. In addition, two students, or 29 percent, discussed how thinking about each individual phase of a project forced them to answer tough questions. Understanding the design process in its entirety also provided important learning experiences. Two of the mentees, or 25 percent, focused on the relationship between problem-solving and the design process. One mentor stated that the process of brainstorming ideas with a group and allowing the design process to develop through conversation provided a valuable learning experience that students may not experience in the classroom. Another mentor identified how the time with the student was so limited that teaching them science and math was not realistic; instead, this mentor helped the student experience the design process.

4.1.2.2 Forces Them to Think About the End User, Budgeting, and Marketing

Table 7. The coding and categorization for thinking about the end user fosters learning

Method	Note	Category 1	Category 2
Interview	Helped with cost and marketing	Skill	Budget/End user
Interview	Show them the budgetary process	Skills to develop	Budgeting
Interview	Analyzed pricing	Skill/vision	Budgeting
Focus Group	Mentor focused a lot on the business aspect	Skill	End user

Table 7 continued

Focus Group	Mentor provide knowledge on production end and business side	Skill	End user
Focus Group	My mentor has really focused on marketing of the product	Skill	End user
Focus Group	Forced me to think the project through and ask about the end product	Skill	End user
Focus Group	Mentor made me think about the product if I were to sell it	Skill	End user
Interview	Provide insight for timing of the product and finances	Vision	End user
Interview	We are able to provide some insight into marketing of products and not just the product itself	Product marketing	End user
Interview	Helped identify the "end user" marketing, etc	Vision	End user

In addition to the design process fostering unique learning, the mentor-mentee relationship provides students with an experience that requires them to understand budgeting constraints and how to market a product, all while keeping the end users in mind. This is an indication that relationships foster the mentees' learning, thus increasing the abilities required to succeed in the STEM-related career. The interview data indicates that six mentors, or 75 percent, were focused on budgeting, marketing, and identifying an end user. One mentor, who is a trained engineer but serves as the director of purchasing for a family-owned company, made the comment that "the mentees were used to a controlled environment, such as school, so it is my job to provide insight into developing a product with an end user and budget in mind." Five comments from four mentees reflected a focus on these areas of budgeting, marketing, and the end user. For instance, one student commented that the "mentor helped me to think about the product in a professional sales context rather than as an academic assignment." This type of questioning seemed to provide learning experiences that was insightful her while she was developing a new type of cast for a wrist injury.

4.1.2.3 Provides a Real World Experience

Table 8. The coding and categorization and how providing real world experiences fosters learning

Method	Note	Category 1	Category 2
Interview	We are able to provide a vision	Skill to develop	Real world experience
Interview	Provide a balance between the practical side of STEM and the pedagogical	Skill to develop	Real world experience
Interview	Provide a reminder/urgency that we need to get things done in the workplace	Skill to develop	Real world experience
Interview	We remind them to have structure in their work	Skill to develop	Real world experience
Interview	We are their window into the world	Vision	Real world experience
Interview	Provides practical experience	Skills to develop	Real world experience
Interview	Sheds light that not everything is perfect in the real world	Vision	Real world experience
Interview	Most engineers wear multiple hats and we are able to show this to students	Vision/Insight	Real world experience
Interview	I am able to share real world issues with the project that a textbook cannot	Vision	Real world experience
Interview	The program is not all textbook	Benefit	Real world experience
Interview	Showed different perspectives	Skill	Real world experience
Interview	Fills in practical piece for students	Skill	Real world experience
Focus Group	We talked about different manufacturing terms	Skill	Real world experience
Focus Group	The mentor provides different eyes on the project	Relationship	Real world experience
Focus Group	My mentor has me focus on the safety of my product since they were goggles	Skill	Real world experience
Focus Group	He helped me with design but safety was number 1	Skill	Real world experience
Focus Group	The mentor is to provide a different perspective and put a different set of eyes on the project	Relationship	Real world experience
Focus Group	Had to develop self-discipline	Skill	Real world experience

The mentor-mentee relationship allows the mentees to come closer to an authentic professional experience than the classroom alone can allow (Means, Wang, Young, Peters, &

Lynch, 2016). This finding was expressed by all of the mentor and mentee participants. The mentees indicated that, through their relationships with their mentors, they obtained diverse perspectives, developed self-discipline, and focused on factors unique to them, such as safety. In addition, the mentors stated that they provided a balance between the pedagogical and the practical side sides of STEM.

Based on the coded and categorized responses, there does seem to be a connection between the amount of structure and time needed to develop a relationship between a mentor and mentee. If mentors know the expectations of the program before entering the relationship, they can allot the appropriate amount of time to meet each of those expectations. In the case of the Fairview High School STEM Academy, the structure of the program helped to initiate the time the mentor and mentee spent together by initially providing guidelines and having the STEM administrator help organize meetings.

In addition to having more structure and time, the idea of having a mentor who is willing to ask questions seems to have benefits. Mentor questioning helped students realize that they have to seek information and that not everything is easily found in a textbook. The mentor was important in setting up an environment in which the student faced adversity and experienced some failure but also established a long-term vision. The long-term vision included thinking about budgeting, marketing, and the end user of the product. In sum, the responses reflect an experience that indicated benefits of the mentor-mentee relationship and its effect on fostering learning in the STEM academy.

5.0 Study Limitations, Implications, Recommendations, and Reflections

5.1 Limitations

Prior to discussing the successes and challenges of this program evaluation, it is important to identify the limitations of the STEM academy. The first limitation is that this was the first year for this STEM academy. There were only 11 students in the program and seven mentors, so the small sample size for participants is a factor. To extend that limitation a bit further, the focus groups consisted of four to six students, resulting in only two focus groups from which to gather data.

Another limitation is my role in the school district. As the students in the focus groups knew me as an administrator, they could have been prone to provide answers that would please an authority to hear. I believe that my prior relationships with these students allowed for an environment of honesty, therefore minimizing making this limitation.

Another limitation is also related to my position in the district but involves the mentors. Since they see me as the district authority and the program leader, they may have provided answers that would not offend me. I do feel that setting the proper expectations at the beginning of the interview process allowed the mentors to understand that a) the inquiry was being conducted primarily to improve the program and b) an honest account of events was needed to order to show improvements.

The last limitation and potentially the most impactful relates to collection and analysis of student log sheets. These meetings that were to be documented on the log sheets were a critical component of the program, given the emphasis on mentoring relationships in helping students to gain skills and knowledge. I only had access to four students' log sheets; of those four, only two had information that could be analyzed. For instance, the student who applied to the board of directors at Penelec only documented one meeting for October 2017 and two meetings for December 2017. The rest of the experience was undocumented. I do know that this student was much more active with the mentor visiting the control room at Penelec a few times and spending numerous hours learning to program his micro-computers. The log sheet was not mandatory and was not monitored throughout the first year of the program by the STEM administrator, and other learning activities took priority over documenting the experience. The analysis of these two log sheets that did contain useful information was limited but both log sheets did show that more structure in the program was needed. Structure was identified in terms of creating more time to meet with mentors, having more concrete milestones, and providing a set time to work on the projects. An example of a successful student log sheet is found in Appendix I, and an example of an unsuccessful log sheet is found in Appendix J.

5.2 Implications and Recommendations: Guidelines for Future Implementation

The purpose of this study was to answer the inquiry questions: What elements are needed in a mentee-mentor relationship? Does the mentee-mentor relationship provide an experience that fosters learning? The data from this inquiry will be used to generate a set of guidelines or blueprint, on how readers can start their own specialized learning pathway that will better prepare students for life after high school.

Utilizing program evaluation techniques, the researcher was able to study mentor/mentee relationships over the course of one year. After the end of year 1, the successes and challenges can be shared out in order for other schools to have a blueprint for setting up their own STEM networks. As the researcher creates the set of guidelines to report on the successes and challenges experienced in year one, it is important to understand other factors, such as, the student population, their projects, and their future plans after finishing the academy. Understanding these factors will allow the user to adapt their program to meet their specific needs. An abbreviated introduction to the mentors will be provided, along with an explanation of academy funding. Lastly, a short description of how our district handled transportation and clearance procedures will be offered.

5.2.1 Guideline 1: The Students Involved

Our STEM academy started with 11 students who were accepted and enrolled in February of 2017. (The student application can be found in Appendix E, the advisory board questions used in the student interviews can be found in Appendix F, and evaluation documents for the interview and the applications for the STEM Academy can be found in Appendix G.) One student mentioned that she thought the academy might provide an experience that could be documented on her college applications. But after experiencing the academy and developing fogless goggles that she calls "foggles," she decided to apply to MIT and is waiting to hear back on their decision. Along with the application to Massachusetts Institute of Technology (MIT), she has applications to Dartmouth, the University of Vermont, and Penn State University. The academy is finishing with 10 students since one was dismissed for not fulfilling the requirements and not keeping up with his project. Three of the other students are applying to Penn State Behrend engineering programs. One student is applying to universities for pre-med, and one female is looking at small private schools to further her education in medical engineering. One male will be attending the United States Coast Guard. Lastly, one male, who created a sensor to be placed on power lines to send notifications of power outages to the local electric provider, has presented his product to the board of directors of Penelec. He is applying to numerous Ivy League schools, including the University of Pennsylvania and Brown University. All of the students are entering some type of STEM field or will attending a military program to specialize in a STEM field. In summary, the completion rate of the academy experience was 91 percent, with just the one student not finishing. The application, the interview process, and the evaluation form seemed to work to allow the board of directors to select academically motivated students who were willing to put in time to have a unique learning experience.

In mid-November of 2018, these 10 students gave their final presentations during a two-hour program that allowed the students to showcase their end product. The first hour was a poster board presentation that allowed the community to mingle around the room and see the products created. Afterward, each student made an oral presentation to the group that described their design work and explained the function of their end product. The products ranged from a protective helmet that a baseball pitcher would wear, to a new safety harness for a roller coaster, to automatically charging piezo boots for military personnel. In attendance were parents, district administrators, school board members, an engineering professor from Gannon University, and an admission counselor from Penn State Behrend. During each presentation, students took the time to recognize and thank their mentors and the STEM Administrator for offering support through the academy.

5.2.2 Guideline 2: The Mentorship

The eight mentors are all trained engineers, but not all are directly using their engineering degree at this stage in their career. Of the eight mentors, four are also parents in our district. For instance, one engineer from LORD Corporation, who is a parent of three children in our district, is serving as a plant supervisor in LORD's Sagertown, Pennsylvania facility. He is in charge of all the engineers and machinists in the plant. He is not directly responsible for engineering but instead is supervising many engineers in practice. His desire to be a mentor in our academy started with his willingness to give back to our school community. He stated, "I think the academy gives our students an advantage and I want to be a part of that." Another mentor, who is currently at GRIMM Industries, is the director of purchasing. His intent to be a mentor in the STEM academy was to give back to a sixteen-year-old. He wanted to share his experiences with high school students in order to provide them an advantage when they decide to apply to college or go into the workforce. The second mentor from GRIMM Industries is the plant operations manager. He signed up as a mentor so he could provide students a real-world experience. His emphasis was on the manufacturing environment and "how you deal with constraints such as equipment and costs." The last mentor, who is also a parent, works at LORD Corporation as well. His title is sections manager in quality. His background is diverse, and he has had many career changes. His undergraduate degree was in chemistry; then he went on to write college mathematics textbooks, and now he is working in an engineering facility. It was his intent to be a mentor so that he could communicate to students the importance of having a diverse education, being adaptable, and working on skills such as problem-solving and communication.

Three other mentors came from LORD Corporation but did not have a connection with the district other than knowing the plant supervisor at LORD Corp in Sagertown, PA. He was responsible for encouraging them to be mentors. The three mentors, two females and one male, all recently graduated from college with engineering degrees and are employed in the Creative Foundations Program at LORD. There program consists of four six-month rotations where they get exposed to different parts of the business before getting placed into a permanent area full-time. They were recruited due to their proximity in age to our students so they could build relationships more easily, especially with female students.

The last mentor was recruited from Penelec since we had a student who was interested in working on the power grid; with the limited knowledge base of our administration and mentors, we sought participation from Penelec. The Penelec mentor was a control room engineer, who spent his time monitoring power in Northwest Pennsylvania and assisting with outages. All of the mentors are coming back for year two and have expressed satisfaction in providing students with an experience that the mentors themselves wished they had in high school.

5.2.3 Guideline 3: Budget/Funding

The STEM Academy at Fairview High School was initially funded by a pilot grant in the amount of $39,150 from the Erie County Gaming and Revenue Authority (ECGRA.) It was the intention of myself and the STEM coordinator to build a STEM network for our high school students and be able to replicate the network with other school districts. ECGRA saw this as an opportunity to establish a program in Erie County high schools that could have long-term effects on the county work force. This grant was written and presented as a joint effort between the curriculum director and the STEM coordinator. Funding was provided to purchase equipment and supplies, such as desktop computers, Raspberry Pi micro-computers, 3D printers, and various items for individual student projects. After year one of the academy, we had spent approximately $22,000, so we can carry the remaining balance to year two. Along with the ECGRA grant, the Fairview School Foundation provided $9,000 for materials to transform a section of our high school library into a learning space for the academy students. Alternative seating furniture, work tables, and large flat screen monitors were included in the space. Since the initial funding from these grants, we have built a line item into our budget that supports the academy on a yearly basis in order to make the academy more sustainable. The amount in our district budget is $10,000.

5.2.4 Guideline 4: Transportation

Although transportation can be a limiting factor for some districts, it was not a hurdle for us. For our on-site visits, our groups were small enough to reserve a school van, and our STEM administrator or a teacher would help transport the students to those sites. The academy students only visited three sites during their experience; therefore, we did not experience any serious transportation obstacles. Mentor/mentee meetings took place on our campus, and our district did not reimburse mentors for mileage.

5.2.5 Guideline 5: Clearance Procedures

Our school district adhered to all clearance regulations put into place on February 16, 2016 in Act 4. We mandated that all mentors obtain the Federal Criminal History Record Information, the Pennsylvania Access to Criminal History, and the Department of Human Services Child Abuse History clearances. We also had all of our mentors voted on and approved as gratis personnel by our school board of directors during a public board meeting. The Fairview School District reimbursed all of the mentors for the cost of their clearances.

5.2.6 Guideline 6: Successes of the STEM Academy

The researcher concluded that our students were entering the STEM Academy with technical skills that were far beyond what the mentors perceived themselves to have had when they were in high school. One mentor from GRIMM Industries commented that "these students are great technically; they have knowledge of 3D printers and software that I still do not have." The technical skills were not the emphasis of the focus group and interview conversations. Rather, the focus was on STEM skills, such as problem-solving, that are needed in order to facilitate students' longer-term professional development. The skills that were needed and were transferred to the students were more in line with skills they may need in professional work environments. The students were forced to struggle through the design process to build resiliency, to ask questions, to examine budgets, and to keep in mind the end users for their products. As we enter year two of the STEM academy, it is reassuring to know that we can rely more on our current curriculum and staff members to support the technical side of STEM and focus on how to develop the professional work skills necessary in any work environment.

Another success was displayed during the final presentation of the STEM academy in the form of the tangible student projects and with their ability to present to a group. Each student is walking away with a working product and a portfolio of experience they can use when applying to college. The students can also take their products to college with them and refine them as they gain post-secondary technical skills and knowledge. For instance, one of the students is leaving with a working model of a protective helmet for a baseball pitcher. That particular student is attending Penn State Behrend, where his mentor also attended school. They both have communicated the idea to expand his product and then to create a mold to manufacture the helmet at GRIMM Industries.

Lastly, the STEM academy has provided our administration, teachers, and board of directors the confidence to build and support other academies that will provide the same type of mentoring relationships and specialized learning path in the areas of business, health and sciences, human services, manufacturing, and arts and communications.

Our decision to create the STEM administrator position was a critical move to making the academy successful in its first year. Having the administrative position dedicated to building the business relationships and overseeing the program is critical. One mentor asked, “What is the sustainability of the program without the current administrator? He does a lot of heavy lifting.” Another mentor recognized our administrator as the key person who was responsible for building the technical capacity in the students and modeling the support to other teachers so they, too, can help the students with their projects.

5.2.7 Guideline 7: Challenges

Although the mentors and mentees all found the program to be beneficial, they expressed a need for a more structured system. Specifically, the expectations for the mentors need to be better communicated, the milestones of the mentees need to be explained in more detail, more instructions for the monthly mentor-mentee meetings need to be present, a better alignment of skill sets for mentors/mentees needs to be considered, and a better vision for the end product needs to be developed.

Two of the female students identified how helpful the meetings were but also recognized how other mentors found it difficult to keep the meetings with the students if something came up at work. The two female mentors stated, “We did not have that problem since we are early in our careers and do not have the same demands that others may have. It was easier for us to get away.”

Their student logs reflected this statement since the two female mentors had a better record of meeting with their mentees.

Although the student logs provided this information, overall they were definitely a challenge to track and monitor. As stated previously, the administrator's time was spent transferring technical knowledge and assisting students, so there was a lack of oversight on the log sheet monitoring.

5.2.8 Guideline 8: Changes for Year 2

Our district has already started the second cohort of STEM academy students. We maintained parts of the program that we found successful. For instance, the application and interview process allowed us to accept a caliber of student motivated by Science, Technology, Engineering, and Mathematics. The mentoring experience was positive overall, and the individual projects pushed the students to apply their knowledge and allowed them to walk away with a unique product and learning experience.

To improve the program, we did make some changes for year two. The timing for matching students with mentors was postponed significantly and intentionally. The first cohort was matched with mentors in the spring of their acceptance year, just a few weeks after being in the academy. For this second year, we allowed the students to perform more research and focus in on a concept a little further before assigning mentors. Our intent is to match mentees with mentors who have some knowledge of the technical side of the project and that may fit better in the mentees' areas of interest. This change resulted from a suggestion by the student who was working on the goggles. She needed help with mechanical engineering concepts, but her mentor was a chemical engineer and was not able to provide much assistance with the mechanical side of her project.

Another change is an orientation seminar being held for all mentors this January. We have developed a guide on how to approach the mentor experience. This change resulted from a suggestion of the plant manager at LORD Corporation. His intent was to have a reference that would include milestones, meeting expectations, student expectations, and budgetary aspects so that all mentors are provided the same guidelines. It is our intent that this process will provide better consistency for all mentors and mentees.

Lastly, we have spent time considering the meeting dates and the documentation of the meetings. We have decided since the mentor experience has been cut back by six months from year one, we can justify setting the expectation to interact with mentees to twice per month. One of those interactions will be face to face and the other interaction can be electronic, either via email or a virtual meeting. To take some burden off the STEM administrator to oversee this process, we have funded a supplemental contract for $1,500 for one of our teaching staff to oversee the meetings and the communication between the mentor and the mentee. This change is designed to address the lack of documentation with the log sheets in our pilot year.

5.3 Reflections

This inquiry and program evaluation has positively affected my approach to better preparing students for life after high school. Specifically, the evaluation of the STEM Academy has reminded me that we can provide all the knowledge and technical skills to students in a controlled environment such as school, but we cannot always replicate other skills needed in the real world. I would not have predicted that nearly every mentor would be highly impressed with our students' technical knowledge, even making comments about how much further along this generation of students is compared to earlier generations. Therefore, the relationship between the mentor and mentee should become more focused on questioning, risk-taking, budgeting, and marketing with somewhat less emphasis on technical skills.

This inquiry has allowed our district to make the necessary changes to ensure the program's sustainability and to clarify expectations for all of the participants. It is the district's intention to begin creating academies that are focused on business, public service, arts and communications, and health and sciences. The successes that were discovered, along with the improvements that are needed, will be used to construct a blueprint for the other academies. With the implementation and adoption of the Pennsylvania Department of Education Career and Work Standards during the 2017-2018 school year, I am sure this information will be valuable to other Pennsylvania districts to ensure their programs are in compliance. I plan to continue to reflect on our program and to share the information with others who may find it helpful.

Appendix A Student Log Sheet

Instructions: Please log each session with your mentor. Please keep this electronically on google docs so district administration can monitor. We will get signatures at the end of the program.

Mentor Name: ______________________ Mentor Signature: ________________________________

Mentee Name:_______________________ Mentee Signature: ________________________________

Mentee's overall goal (s): ____
____
____
____

Date	**Time From: To:**	**Description of Activities**	**Progress Toward Goal**	**Plan for next meeting**	**Total Time**

Appendix B Focus Group Questions

Justin Zona
University of Pittsburgh
Focus Group Format and Questions for Fairview High School STEM Academy mentees.

Welcome
Our topics today will be to gain insight on your experience in the STEM academy, particularly with the mentor relationship and how it impacted your experience.

The guidelines are:

- we must understand there are no wrong or right answers
- one person will speak at a time
- we must mutually respect others even if we do not agree
- no cell phone or tablets will be used to record the conversation by the participants but the moderator will be using an electronic device so they can go back and take better notes
- my role is to guide the discussion

1. What did you think about the STEM academy?
2. What did you like best about the STEM academy?
3. What skills do you feel the mentor helped you develop?
4. How did your mentor help develop these skills?
5. What could administrators and teachers do to make the program better?
6. What can mentors and mentees do to make the program better?
7. How has the mentor helped form your goals for after high school?
8. How critical is the relationship between the mentor and mentee to increase learning beyond our classroom?
9. Would you do this program again or would you recommend this to an underclassman?
10. What would you tell underclassman or another student about this program?

Appendix C Interview Questions

Justin Zona
University of Pittsburgh
Program Evaluation-Fairview High School STEM Academy

Interview Questions for Mentors
Name: ____________________________
Company: _________________________

1. What is your role in that company?
2. Why did you sign up to be a mentor?
3. What has been the best part about being a mentor?
4. What has been the most challenging part about being a mentor?
5. The goal of the STEM Academy is to better prepare students with STEM skills so they can successfully enter the workforce or post-secondary education. How have your interactions with your mentee helped achieve this goal?
    a. What actions did you take to help achieve this goal?
    b. What would you change to better achieve the goal?
6. What are some of the STEM skills that you helped your mentee develop?
7. Are there any STEM skills you did we need to cover more in depth so that we better prepare the students?
8. Thinking about what worked for the mentoring program in year 1, what aspects would you keep the same?
9. What are some things you learned as a mentor from this experience?

Appendix D IRB Documentation

Ivanusic, Carolyn

Wed 9/6/2017 2:04 PM

To Zona, Justin Q <JQZ1@pitt.edu>;

Justin,

Thank you for speaking with me today. As discussed, you will be conducting a program evaluation in the school setting, potentially including interviews / focus groups with mentors/students, and review of documents such as log sheets. Because you would already be conducting this evaluation separately from any intended research, and you will not change or add procedures to the evaluation for research purposes, these procedures do not constitute human subjects research activities requiring IRB review. Similarly, all literature review procedures do not constitute human subjects research. The analysis of the results of these procedures is also in line with what would be done in a program evaluation.

Note that you can still publish / share the results of the evaluation even though it does not fit the definition of human subjects research requiring IRB review.

In summary, the activities planned do not require IRB oversight and no protocols is required. Please let me know if you have any questions, and feel free to share this email with your committee as documentation of our discussion.

Best of luck with your dissertation!

Carolyn

****

Carolyn Ivanusic, MSW CIP
Research Review Coordinator
University of Pittsburgh
Institutional Review Board / Human Research Protection Office
Hieber Building, Suite 106
3500 5th Avenue, Pittsburgh PA 15213
Phone: 412-383-1789
Ivanusic@pitt.edu

Appendix E STEM Academy Application

Thank you for your interest in applying for the STEM Academy. The following steps are required as part of the enrollment process.

Step 1. Stop into the guidance office to have a signed copy of your transcript attached to your application.

Step 2. Compete the student portion of the application.

Step 3. Ask two teachers to complete the Teacher Evaluation Forms.

Step 4. Have a parent or guardian sign your application.

Step 5. Return your application to the guidance office by _______________.

Last name _______________________________ First name________________________

Current grade ______________ Grade Point Average _____________

Why have you chosen to apply to the STEM academy?

Why do you feel you will be successful in the STEM academy?

List other information that you would like us to know about yourself.

Please list the names of the two teachers that you are giving the Teacher Recommendation forms to complete.

1.____

2.____

Parent/Guardian
Signature____Date__________

Appendix F STEM Academy Interview Questions

Student Name: ____

1.)Tell us about yourself and why you applied for the STEM Academy.

2.) In your application you stated you were interested in:

____

Tell us more about that.

3.) What ideas do you have for your STEM Project?

4.) What are some experiences you've had collaborating and/or working with others to complete a project? In addition to working with students, what are your experiences working with adults?

5.) Tell us how you manage your time with a busy schedule. Do you foresee any issues meeting the summer requirements of the program?

6.) Do you have any questions for us?

Appendix G STEM Academy Applicant Evaluation Form

Student Name: ____

Academic Potential:

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Notes:

Communication Ability:

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Notes:

Time Management:

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Notes:

Collaboration:

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Notes:

Appendix H STEM Administrator Job Description

FAIRVIEW SCHOOL DISTRICT – POSITION DESCRIPTION

LOCATION: Fairview School District

TITLE: Gifted/STEM Administrator

QUALIFICATIONS:

1. Pennsylvania K-12 Principal Certification
2. Working knowledge of PA Gifted regulations
3. Experience teaching STEM related courses

REPORTS TO: Superintendent of Schools

POSITION GOAL: The Gifted/STEM Administrator is responsible for planning and supervising the Fairview School District Gifted program. Additionally, he/she will provide leadership and overall administration and coordination of the STEM program.

POSITION RESPONSIBILITIES:

Gifted Responsibilities

1. Assist with the placement of elementary/secondary gifted students in appropriate educational services and settings.
2. Collect, interpret, and analyze achievement data to determine the identified students' present levels of performance.
3. Supervise and evaluate Gifted teachers and the overall operation of the Gifted program.
4. Organize a team to determine for each identified student appropriate educational services and settings based upon the present levels of performance.
5. Design for each identified student a Gifted Individualized Education Plan (GIEP) that describes how best to meet his/her individual learning needs.
6. Ensure that all paperwork is signed and processed according to Chapter 16 Gifted regulations and District protocol.
7. Instruct classroom teachers of identified students on the terms of Chapter 16, and their responsibilities as applicable to gifted and talented students.
8. Review Chapter 16 regulations and keep classroom teachers of identified students informed of changes to the law and their responsibilities as applicable to gifted students.

STEM Responsibilities

9. Evaluate and supervise teachers in the area of math, science, and technology.
10. Promote effective instructional practices and communication that support high levels of instruction through the use of research-based data driven best practices, effective classroom consultation, and program evaluation.
11. Oversee, manage, and develop the Fairview School District STEM Academy, including the selection of candidates, evaluation of related materials, and coordination of mentors and job shadowing experiences.
12. Monitor school data to determine trends and in turn develop and implement the most effective strategies for meeting and exceeding state and national student achievement goals.
13. Lead a process for the evaluation, selection, and acquisition of instructional materials, supplies, equipment and textbooks to support the STEM curriculum.
14. Advise administrators and teachers in evaluating and improving classroom instruction in the STEM programs.
15. Develop a proposed annual budget relating to STEM curriculum development and the instructional materials needs of all schools.
16. Supervise the planning and delivery of District instructional in-service programs for teachers, aides, and parent volunteers to assist in raising the level of instructional performance and student achievement in the STEM programs.
17. Prepare narrative and statistical reports regarding the STEM programs and provide support to administrators and teachers in data-driven decision making to improve student achievement.
18. Perform other such duties as assigned by the Superintendent.

TERMS OF EMPLOYMENT: Twelve-month basis. Salary and work year to be negotiated with the School Board.

EVALUATION: Performance of this job will be evaluated annually in accordance with provisions of the Board's policy on Evaluation of Administrative Personnel.

Appendix I Successful Meeting Journal

MENTOR MEETING JOURNAL

This journal will be a log of all communication between you and your mentors. Emails, phone calls, and mentor meetings will be recorded within the document so you can review and track your work with your mentors.

Mentor: [redacted] STEM Academy Student: [redacted]

Date:	**Time:**	**Communication Tool**: (email, phone call, meeting)	**Meeting Details:** Provide a brief description of the meeting and list content of the meeting.
Ex: 10/4/17	Ex: 2:15pm	Ex: Mentor Meeting	Ex: Presented the first product idea to my mentor. We discussed the following topics: ●Patents ●Product Design ●How the Product Works
9/29/17	9:00am	Mentor Meeting	Presented background research, concept, and plan to my mentor. We discussed the following topics: ●Method to heat lenses ●Heat sink ●Battery sizes ●Testing wire for temperature where plastic might melt or not be defogged at all
11/10/17	9:00am	Mentor Meeting	Presented sketches, portfolio, wire experiments, newly learned math, rough prototype, and future plan to my mentor. We discussed the following topics: ●Circuit anatomy ●Resistor size ●Ohm's law ●Power equation ●Thermally conductive and dissipating glue from LORD ●Duty cycle idea to work like oven ●Code to make switch for duty cycle so

			on and off to maintain temperature
12/1/17	10:00am	Email	[redacted] Sorry about no weekly update last week and that this is a day late (I ran out of time yesterday). We had a short week and only 2 days of school so I didn't have much to report on. However, this week I have made a few discoveries. I got a mini-lesson on AC vs DC and now better understand how the multi-meter works. I also glued my 24awg nichrome wire to the inside of a goggle lens and tried to heat it up. With even no resistors, the wire and glue got hot, but not the plastic. See the attached picture 0683. I understand that the lenses are polycarbonate so they are not very thermally conductive. Upon exploring some websites, I found a company that seems to make thermally conductive plastics, and I contemplated emailing them to see about getting a sample but am going to try other things first. Today Mr. Bookhamer helped me make a small grid of thinner, 30awg nichrome wire on a goggle lens just taped on with Scotch tape. I had no resistors because the nichrome seemed to have a high resistance, and just shorted a battery essentially but the plastic got to about 110 degrees F which was good, and the wire itself went to about 180 but was continuing to increase. See the attached picture 0703. I put the whole setup in the fridge to make it cold and brought it out to see the lens fog up, and then put it back in and brought it out, immediately attaching my battery to see if I could prevent the fogging by getting the lens hotter with more wire coverage. It worked!!!!!! The lens with the wire and battery cleared up within about 7 seconds and the other lens that was just plain stayed foggy. I touched the lens with the wire setup and it was not too hot to touch or anything. I will continue these tests next week to refine the wire grid and battery connections. Other things I am going to try are either buying cheap thin phone screen protectors and cutting a shape to put on a lens to hold wire down, or I might buy a little bit of clear epoxy and either coat the wire on the lens with that or coat it and put a microscope cover slip on top. I will let

			you know next week what I try and what seems to work the best. I have also attached my weekly timeline as a PDF that summarizes this email. Thanks and have a great weekend!
12/8/17	10:00am	Email	[redacted] This week I refined the wire arrangement (see attached picture) and this weekend will figure out how long it should last and will test it to see if the battery actually lasts. Now that I have a proof of concept because I know the wire can make the lens hot enough. The next step is to learn how to control it because what happens is that the wire and lens just keep heating up, so I am going to use electronics to make a circuit that will sense the temperature and break the circuit to stop heating the wire when it gets to a circuit high temperature. When the temperature is lower, it will turn back on and just go back and forth so the circuit does not overheat. I know just about nothing about programming so this week I began to learn how I could use Arduinos and Sunfounder technology to make it work. First I make an LED light turn on with a button. Then I attached a relay and it was switching the current on and off. Both the button and relay circuits were with sample code, but with the help of [redacted] I combined the codes and used the relay to make the LED flash! Then I replaced the LED with my goggles and when I pushed the button, the relay closed the circuit and the lens got hot, and when I released the button they cooled off! It was super cool so now that I have it mechanically I am trying attach a temperature sensor and my own code to turn it on and off. I will let you know when I figure it out! Also I know the pictures are tedious and the computers and things are way too bulky right now but it's just for a prototype and it will be able to be downsized later. Thanks and have a great weekend! [redacted] P.S. I also attached my timeline and a PDF as usual. I made an automated circuit with [redacted] help and had wire on my lenses and used Arduino code

			to turn the circuit on below 115 degrees F and off above it and it worked!!! here is a confusing picture of what was happening. I used my regular thermocouple to monitor the temperature, and was seeing the Sunfoudner thermistor readings on the computer screen and the relay was switching on and off and keeping the temperature right about 115 by it's readings but 130 on the regular thermocouple but either way it's close enough for right now and it worked!
12/14/17	9:30am	Mentor Meeting	Presented working, non-wearable prototype to my mentor We discussed the following topics: ●Thermally dissipating glue from LORD can be used later when encase components and need them to not overheat ●How to downsize with smaller computer components ●Options for placement of electronics (side, back) ●Wire arrangement (one loop covering both lenses with loop/grid on each one) ●Battery life (high mAh batteries)
12/22/17	10:00am	Email	[redacted] This week I have kind of hit a rut because I'm not sure how to find a pic chip to program/how to use the smaller Arduino but I am going to focus on that after break. Over break I am going to get some resin or epoxy or silicone or something that is clear to try using it on the lenses when I have both lenses being heated. The goal is to heat the lens more because the plastic is not getting hot enough with just wire on both lenses. I might also work with battery life a little. I attached my timeline as well. Have a great holiday! Thanks,
1/26/18	9:00am	Email	[redacted], This week has been tricky because our new semester independent study has much less teacher assistance due to [redacted] actually having a class. I tried to program a pic chip and tried to just take one off the Arduino but it did not

			work, probably because I have no idea how to do it. However, I put my prototype back together and I think I have a wire arrangement that works okay even on the non-thermally conductive polycarbonate. It's a little imperfect because I am using Scotch tape but that is a detail for later and that I am also trying to figure out currently. So where I am going with this is that [redacted] ordered these really tiny Arduinos that I am going to try to program when they arrive which should help with downsizing a lot. The other thing I have been trying to do is find a thermally conductive clear material which I think just does not exist because you seem to need metal to conduct heat, and metal is not clear. Do you have any suggestions? That would be awesome, because I know there are snowmobile helmets that have only a little wire and the shield defogs with heat, but I can't seem to find out what material those are made of. Though they also have vents, so that could contribute. But overall, I am still trying to downsize-I think that is my biggest hurdle right now. Then I can maybe just embed wire in a mold of a goggle, and if I need more wire but lower resistance the wire has to be thicker which is why embedding it will work better because tape does not hold thick wire down very well. The challenge with embedding is how I make a mold and then mold something... But I'll get there. Using thicker, lower resistance, embedded wire would also allow me to have only one wire loop across both lenses and one computer in the strap instead of a mirror system on each side. I will show you when we meet next week, and I attached a picture of the wire grid with scotch tape that has worked the best so far. Thanks, and see you then!
2/2/18	8:30am	Mentor Meeting	Presented better working, non-wearable prototype, Arduino nano initial stages, and new lens idea to my mentor We discussed the following topics: ●Programming Arduino nano ●Using plastic cup propyl ethylene or acetate to sandwich wire between layers ●Having a mirrored system on each side

			●LORD clear thermally conductive adhesives ●Thermistor placement ●Future steps, waterproofing, mid-year review
3/12/18	8:00am	Mentor Meeting	Presented almost wearable sized prototype, Flex printed rubber seal and regular potential lens frame, resin casts, vacuum formed lenses, reported about the relays We discussed the following topics ●Ordering other plastics ●How to use LORD clear thermally conductive adhesives ●How to turn my one lens system into two ●Waterproofing ●Battery pack ●Arduino battery ●Electronics encasing
3/23/18	8:20am	Email	[redacted] This week my tiny relays from Pickering came in, and they are REALLY tiny. It's super cool, but I can't use just the relay in my circuit because the one I have that works also has a special board that allows it to work with the Arduino. I learned a bunch about how relays work through coming to that conclusion, so that was nice to better understand them now. I am just going to leave the working Sunfounder relay and work on the battery case. Before I make the battery case I will make a working prototype circuit that I won't tamper with because I kind of broke my current one by messing with it. Next week is spring break, so I'll start working the week after that and we can set up an April meeting later. Thanks! [redacted]
4/24/18	7:45am	Mentor Meeting	Presented 3-D printed holding case and problems with inconsistently functioning Arduino We discussed the following topics ●Resistance/voltage at certain points in circuit ●Lens battery ●Thermistor length

			●Idea of talking to a professional about downsizing once get functioning code
5/17/18	8:20am	Email	[redacted] Sorry I haven't checked in in a while, things have been crazy! But basically I've come to the conclusion that my system works best with fresh batteries and that the temperature control is not perfect but there's not much more for me to mess with with it. I have a new thermistor that works a little better and we just had an end of the year review last night where I presented my progress and working prototype. Hopefully by the end of next week I will test the LORD substance on a lens and start to work on in-water testing or a more compact case. This is what I presented last night: image1.jpegimage2.jpeg Now that AP tests are over (last one today!) I can hopefully speed up progress. When would you and [redacted] like to meet for May? Please note we have no school Monday the 28th. Just let me know! Thanks, [redacted]
5/24/18	8:00am	Mentor Meeting	Presented glued lens, more compact cases, new thermistor, and water-test results We discussed the following topics ●How to make batteries replaceable ●Different thermistor trials ●Two lens-system ●Provisional patent ●College ●Smaller computer ●How to take to company ●End of year and end of summer goals

Appendix J Unsuccessful Student Log Sheet

MENTOR MEETING JOURNAL

This journal will be a log of all communication between you and your mentors. Emails, phone calls, and mentor meetings will be recorded within the document so you can review and track your work with your mentors.

Mentor: [redacted] STEM Academy Student: [redacted]

Date:	**Time:**	**Communication Tool**: (email, phone call, meeting)	**Meeting Details:** Provide a brief description of the meeting and list content of the meeting.
Ex: 10/27/17	9:30 AM	Meeting with Mr. Bookhamer	Asked multiple question about power consumption and finalized components of the power monitor. Stated that the monitor should use Li-ion batteries and that power consumption was a highly fluctuating yet easily fixable part of a microcontroller project.
12/11/17	9:30 AM	Meeting	Showed [redacted] progress I made. He seemed to like it. Suggested that I should use a live wire to test the sensor. Discussed building a web app.
12/18/17	9:30 AM	Meeting	Showed [redacted] the circuit I was building. We discussed different ways of building the circuit to step down power to the battery and microcontroller without use of a solar controller. We also discussed the software. I told him I was leaning away from socket communications due to difficulty, and he said to just provide proof of concept (a simple email or LED blink will be fine).

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