FEMALE STUDENT PERSISTENCE IN STEM COLLEGE PROGRAMS

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Abstract

This study focused on understanding female student persistence in a STEM community college program. The researcher conducted a mixed-methods study which utilized a student survey that asked both male and female students questions focused on encouragement received in school and perceived persistence level to complete their STEM program. Interviews were conducted with second-year community college female students in the program who completed the survey. Results found stronger encouragement for males in their school careers while female students reported stronger feelings of persistence in the college STEM program. Interviews showed that female students expressed a recurring theme of family encouragement while growing up as well as an adult or sibling role model who used technology which may have led to stronger program persistence. Self-efficacy and student maturity were also highlighted in interviews as a reason to persist and complete STEM programming. This dissertation recommends further study into support from the home lives of students outside of school as a building block to persistence in STEM as well as the creation of college structures, such as trained advisors who have a deeper knowledge and understanding of STEM, so that students can be directed more effectively to STEM programs.

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Finally, to the students in the school district and community college where I teach, I hope this research is applicable to making your journey more equitable and ultimately successful. You are the reason why I love to teach and the inspiration for wanting to create an educational experience that is positive, valuable, and accessible to all students.

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CHAPTER ONE: Introduction

Science, Technology, Engineering and Mathematics (STEM) college programs have a direct link to the fastest, and highest-paid, career fields in today's economy (Sublett & Plasman, 2017). Sargent (2014) writes that the engineering field alone is expected to expand 8.6% by 2020. Smith, Jagesic, Wyatt, & Ewing (2018) predict this growth will lead to nine million STEM jobs within the same time period. These positive outlooks for STEM provide colleges with a reason for excitement but also with a tremendous challenge because there may not be enough workers to fill those jobs.

Belser, Shillingford, Daire, Prescod, & Dagley (2018) write that the United States lacks the qualified people necessary to keep up with demand in STEM career fields, a finding echoed by Smith, Jagesic, Wyatt, & Ewing (2018) who believe that there are not enough students in the STEM college pipeline to meet the needs of the job market. King (2016) found that 45% to 50% of students who enter STEM do not earn a STEM degree. Smith et al. (2018) warn the United States will not have enough students completing STEM degrees to fill the growing demand.

The problem of not enough workers in STEM certainly runs counter to the perception of a rapidly growing field, but the issue becomes more acute when broken down by gender. Mau (2016) writes that while the number of female student enrollment in colleges has surpassed men, there is a continual underrepresentation of female students in STEM. Those females who graduate from a STEM program are less likely to enter STEM fields as detailed by Beede et al. (2011) who found that 40% of men who earn STEM degrees enter into a STEM career compared to 26% of females with a STEM degree. This creates a moral and practical problem as graduates who enter STEM careers earn 33% more than those in non-STEM careers or those without STEM degrees (Belser et al., 2018).

The reasons for the lack of females entering STEM fields are many, ranging from overt sexism to much more subtle forms of gender bias, such as calling on males more often or interrupting female students when they speak (King, 2016). The issue of finding workers must target females and other groups traditionally underrepresented in STEM as explained by K. Smith et al. (2018) who writes "a match between open STEM positions and number of STEM educated workers is possible only if underrepresented groups -females, minorities, and first-generation students- become proportionally represented in STEM education" (p.6).

This mixed-methods study hopes to show that by investigating female students' experiences in STEM college programs, there can be valuable knowledge gained as to what serves as barriers and incentives to female student persistence. The following discussion will review the need for this study, its significance compared to existing research, and the research questions that will be answered by conducting this study. Subjects' answers could provide valuable insight into how to make STEM programs more welcoming (Sass, 2015). Findings from this study could be used to craft policies for STEM programs that honor the lived experiences of female students and allow colleges to construct administrative scaffolding that target areas found to be deficient.

Need for the Study

While not all CTE programs at the secondary education level are specifically STEM related, they provide a snapshot of student enrollment in programs that connect to high-demand vocations (Palmer & Gaunt, 2007). Nationwide, for the 2016-2017 class there were 4,492,189 male students and 3,847,741 female students enrolled in secondary education CTE programs ("Perkins Data Explorer," 2019). In Pennsylvania, these numbers translate to 37,273 male students and 26,574 female students in CTE ("Perkins Data Explorer," 2019). Numbers for the

2016-2017 class flip for genders when looking at post-secondary CTE enrollment with 1,938,046 females enrolled compared to 1,740,535 males nationwide (“Perkins Data Explorer,” 2019). For Pennsylvania, enrollments were 37,375 for females and 29,713 for males (“Perkins Data Explorer,” 2019).

Female students make up a larger majority of the college population than males but they are not entering STEM majors. The Pennsylvania State System of Higher Education (2018) reports STEM fields as the second most popular undergraduate major with 14,503 students enrolled, just behind Business Management with 14,617 total students. Females hold 57% of all bachelor’s degrees and 50% of all science and engineering degrees but the number of computer science and mathematics degrees held by females has declined since 2004 (National Science Foundation, National Center for Science and Engineering Statistics, 2017).

With a growing need for STEM workers it is critical that female students persist through STEM college programming so they can fill these open job positions. Noonan (2017) found that in 2015 there were 3.4 million female workers in STEM fields compared to 7.9 million male workers. Of STEM degree earners, females make up only 15% of those with Associate degrees and 18% with Bachelor degrees (Zheng, Stapleton, Henneberger, & Woolley, 2016). Demand for graduates with STEM degrees and STEM career interest will continue to increase in the coming years directly affecting the future economic strength of the United States if these jobs remain unfilled (Sublett & Plasman, 2017).

Statement of the Problem

Science-based disciplines already struggle with high failure rates in classes, low student retention rates in majors, and lower than average program completion rates (Carrino & Gerace, 2016). Technology-heavy college majors tend to enroll smaller numbers of females initially and then see many of those students transfer out of these computer-based, male-dominated majors as they proceed through these programs (Kugler, Tinsley, & Ukhaneva, 2017a). Hamilton et al. (2015) write that gender disparities may be evident in high-technology programs because of a lack of self-confidence around technology and loss of interest in science and math during secondary education.

Ausburn et al. (2009) explain that a predominately-male college program can send negative messaging to female students, reinforcing social factors such as traditional roles of males with technology and low female self-efficacy with technology. There is a need for more research into how these programs are structured, the resources they provide to struggling students, and how effective their pipelines are to professional opportunities in STEM fields (Kugler, Tinsley, & Ukhaneva, 2017). Klein et al. (2007) expand on this need:

> The magnitude of the enrollment disparities found in the research indicates that these patterns are not the product of unfettered choice alone, but rather that discrimination and barriers are limiting young men's and women's opportunities to pursue careers that are nontraditional to their gender. (p.8)

These disparities have led to a lack of female workers in high-technology fields with only 36% of middle-skill jobs and 29% of well-paying IT jobs held by women (Lekes, Bragg, Loeb, & Oleksiw, 2007). Looking to the technology workforce itself, Hamilton et al. (2015) report female workers earn 81% of the median wages earned by male workers and that females have strong employment numbers in only 20 of 400 STEM job categories, generally in those fields that are lower-paying. Noonan (2017) found that those females who do make it to STEM occupations earn $31.59 compared to $37.69 for males based in 2017 dollars.

The purpose of this study is to determine what factors and lived-experiences affect female student persistence in higher education STEM programming, if there is a "critical point" in these programs where they tend to decide to persist or to transfer, and whether prior experience in CTE secondary education programming, which has strong thematic links to STEM, has an effect on college program completion.

Definition of Terms

CTE and STEM present their own set of terminology and definitions. To clarify the vocabulary throughout the research, national sources such as the American Youth Policy Forum (AYPF), the Association for Career and Technical Education (ACTE) and National Center for Education Statistics (NCES) have been used for standardization.

Career and Technical Education (CTE) – Educates students for a range of career options through 16 career clusters and more than 79 pathways. CTE encompasses programs in high schools, career centers, community and technical colleges, and four-year universities (What Is CTE? - ACTE, 2018).

CTE Courses – Pennsylvania Department of Education-approved programs in secondary schools which comply with federal Perkin's Legislation mandates, including alignment to state-defined to high demand career fields (Pennsylvania Department of Education - Career and Technical Education, 2018).

Career Pathway – A coherent sequence of rigorous academic and technical courses that allows students to apply academics and develop technical skills in a curriculum area (American Youth Policy Forum | AYPF, 2018).

Certificate – An award granted for the successful completion of a sub-baccalaureate postsecondary program of study (NCES Home Page, part of the U.S. Department of Education, 2018).

Competency-based Learning – Students advance upon mastery of explicit, measurable, transferable learning objectives (Competency-Based Education Resources | American Youth Policy Forum, 2018).

CTE concentrator – Those who took three or more courses in the same labor market preparation area (NCES).

Dual enrollment – A program offered by a partnership between an institution of higher education and at least one local education agency through which a secondary school student who has not graduated from high school is able to enroll in one or more postsecondary courses and earn credit that is transferable and applies toward completion of a degree (Career and Technical Education, 2018).

Encouragement – Gained confidence reflected in increased self-efficacy which may lead to persistence in STEM programming (Sublett & Plasman, 2017).

Encouragement Score – The mean score of responses in this study's survey focused on student encouragement.

Female student – A student who identifies as female and is enrolled in their Sophomore year or later in a STEM program at a community college in southeastern Pennsylvania.

Perkins Legislation – The Carl D. Perkins Career and Technical Improvement Act of 2006, which makes federal funds available for states and localities to develop academic and technical standards to assist students in preparation for high skill, high wage, or high demand occupations in current or emerging professions (Perkins, 2018).

Persistence – Internal personality features that allow students to persevere in STEM college programs (Simon, Aulls, Dedic, Hubbard, & Hall, 2015).

Persistence Score – The mean score of responses in this study's survey focused on student persistence.

Program Completion – Academic success as defined by the college in accordance with each major, state standard, vocation, etc. This can include an associate degree, completion of a skills test, apprentice, panel review, or a certificate of completion

STEM Self-efficacy – Self-evaluation of one's ability in the concepts and principles of science, technology, engineering and mathematics required to complete STEM coursework. (Liu, Lou, & Shih, 2014)

STEM – Programs that focus on the fields of science, technology, engineering, and mathematics generally focusing on high-level knowledge, skills, and abilities needed in the current job market (Career and College Exploration in Afterschool Programs in STEM | American Youth Policy Forum, 2018).

STEM Careers – Professional and technical occupations in computer science, Engineering, and life and physical sciences (Beede et al., 2011).

STEM College Programs – At the college in this study, the following majors fall under STEM programming: Biotechnology, Computer-aided Drafting and Design, Computer Networking, Computer Science, Electronic Game Design, Engineering, Information Technology, Mathematics, Physical Sciences, Software Engineering, and Web Development (Science, Technology, Engineering & Math: Montgomery County Community College, 2018).

Researcher Positionality

Creswell & Creswell (2018) write that qualitative research is interpersonal because of sustained contact with study participants necessitating an explanation of the researcher's personal background, values, and biases. Bourke (2014) states that the researcher's positionality is determined by where one stands in relation to "the other." During this study, the primary researcher held a teaching position at a high school focused on technology and retained an active vocational teaching certificate. He interacted with students enrolled in Career and Technical Education programs, though none of those students were in the sample of this study. The researcher also held an adjunct teaching position at the targeted college but was not actively teaching during the semester when the research was conducted and has never held a position as an instructor in the STEM school within the college.

While the phase one electronic survey involved no personal interaction, and a research assistant was available to disseminate paper surveys, the phase two interviews did necessitate direct contact between the primary researcher and subjects. The primary researcher had no formal or personal connection to any of the subjects who showed interest to be interviewed. In interview discussions the researcher made particular effort not to encourage or discourage behavior regarding STEM, provide advice, or otherwise interact outside of the questions provided Interview Guide (see Appendix E). Follow-up questions not listed in the Interview Guide generally asked for refinement or more detail on a given answer and were consciously not used to otherwise influence the subjects (see Appendix F).

Limitations

This research contains the following limitations:

First, this study seeks to find the reasons for persistence in STEM programs for female students at one community college in southeast Pennsylvania. While this study may provide useful data and conclusions to the institution where this research was conducted, its findings may not be able to be generalized to additional institutions (Cone & Foster, 2006).

Second, participation of females willing to interview in person was limited. The researcher anticipated 8 to 10 respondents willing to schedule an interview after 35 completed the initial survey; however, there were only 3 females who sat for the full interview.

Research Questions

The following research questions were used to guide this study:

1. What keeps students, and in particular female students, persisting through successful completion of STEM college programs in a community college?
2. What are the lived experiences of female students in STEM community college programs?
3. What are the “critical points” where female students tend to persist in STEM college programs?
4. How have the lived experiences in secondary education STEM and CTE programs influenced student persistence toward successful completion of STEM community college programs?

Summary

Female student enrollment in STEM college programs tends to be low compared to males and shows drop-off as these students transfer to other, non-STEM majors in numbers much higher than males. There is a growing need for workers in STEM fields but not enough workers to fill projected future openings. Females already show low numbers in these job fields which only exacerbates pay inequality as these jobs tend to pay more than jobs outside of STEM. Any solution to increasing workers in STEM fields must include increasing the total number of female STEM degree earners and ensure that they remain in the field after graduation.

This study looked at what keeps female students persisting in STEM community college programs at a college in southeastern Pennsylvania, what their lived experiences are in these programs, whether there are specific “critical points” when they may choose to persist or drop out, and if previous high school CTE courses and programs have an effect on these experiences and rates of persistence.

CHAPTER TWO: Literature Review

This chapter is focused on two major areas of the scholarly literature. The first part will review the theoretical frameworks for persistence and how students build self-efficacy. The second part will describe the latest research as related to STEM, gender impacts, how community colleges focus on enrollment, and internship activities. Finally, the chapter will detail how CTE programs are funded, implemented at the state and local level, and describe research into how it connects to higher education through dual enrollment, orientation programs, and real-world partnerships, internships, and career training.

Theoretical Frameworks Overview

This first section reviews the theoretical frameworks for persistence that focus on Social Cognitive Theory and theories of how students build self-efficacy. Social Cognitive Theory suggests that humans are energetic actors in their own lives, as opposed to passive onlookers, and that factors that may build persistence are fluid and constantly changing (Bandura, 1999). Social Cognitive Theory, and its offshoot Social Cognitive Career Theory, offer insights into how students may be initially attracted to STEM majors and what may keep them in these programs through completion. Both theories have a strong attachment to theories of self-efficacy, where personal characteristics or qualities form a student's perceived capability, and expectation for success is based heavily on prior achievement (R. A. Simon et al., 2015).

Social Cognitive Theory advocates for strong role models, much in line with the current shift away from teacher-focused education, where the teacher is the "sage on a stage" relaying information to students, and toward a rich and layered relationship between students and teachers. Examples of this student-focused model can already be found in colleges through flipped classrooms, peer learning, problem-based learning, cooperative learning, and experiential learning (Carrino & Gerace, 2016). This student-focused educational model relies on teachers as role models and guides and can be particularly effective when linked to career and skills-training programs offered in STEM, which can have a direct influence on students' career ambitions (Liu et al., 2014).

Theories of Persistence

Social Cognitive Theory

Social cognitive theory originates from the social learning theories of Albert Bandura, who explores the role of cognition and belief on career decisions, emphasizing that an individual's self-efficacy has an influence on performance (Liu et al., 2014). Bandura (1999) believes that the self is primarily a product of social forces, which can have a major effect on individual student outcomes. Factors such as family life, influence of friends, and encouragement of mentors and teachers would have a particularly strong effect on students' feelings of self-efficacy and career decision-making (Xing & Rojewski, 2018).

A high sense of self-efficacy allows for finding, creating, and maintaining social relationships which can make stressors easier to manage (Bandura, 1999). Social ecosystems must be built and nurtured for students through college program relationships as well as traditional social networks (Carrino & Gerace, 2016). Job training, mentorship, and technology exposure can change student interests depending on whether self-efficacy beliefs grow or decline (Lent, Brown, & Hackett, 2002). Liu et al. (2014) found correlation between strength of gender role beliefs in students and their exposure to engineer role models, contributing as a major factor that influenced women's STEM self-efficacy and professional commitment to engineering.

There is also a strong connection between the technical training inherent in STEM programs and the careers that this training directly helps students achieve. For example, Graphic

Design classes within Communications Technology CTE programs use industry-standard programs, such as Adobe Photoshop or Adobe Illustrator as benchmark achievements. These programs are then used by companies in internships and in related job fields after graduation, making their mastery at college critical for career attainment. The tie of STEM to career training creates an intriguing new layer to social cognitive theory, called social cognitive career theory, which works to explain how academic and career choices are developed and how successes from these choices are defined (Lent et al., 2002).

While technical mastery of needed skills is required for graduation, artistry also plays a role in enticing students into STEM majors and careers, at least initially. Lent et al. (2002) write that "for interests to blossom in areas for which people have talent, their environments must expose them to the types of direct, vicarious, and persuasive experiences that can give rise to robust efficacy beliefs and positive outcome expectations" (p. 752). STEM programming would seem to offer plenty of options to lure female students into programs and to persist, based on its flexibility and dynamic range of majors and career opportunities, but these must be continually nurtured and tied to attainable challenges in order to lead to skill mastery and program persistence (Davis, 2014).

Where self-efficacy and social cognitive career theory meet, Lent et al. (2002) write of a self-efficacy 'feedback loop' where a student likes an activity and will then find ways to increase their exposure and involvement with that activity, which raises their mastery of the activity and then expectations of success with that activity, which in turn, increases commitment, time, and engagement with the activity. STEM has this same potential when students can be engaged with majors and career paths that interest them, allowing them to build their skills, and then rewards them with tangible skills increases and, more concretely, passing grades and advancement in the program.

Self-efficacy

Self-efficacy may offer reasons why students are likely to become interested in, pursue, and perform well in activities where there is strong internal confidence and belief in success. Students with strong belief in their capabilities will likely work harder in the face of difficulties while those who doubt their skills may give up or settle (Bandura, 1999). The higher the sense of self-efficacy, the greater the effort, persistence, and resilience (R. A. Simon et al., 2015). Self-efficacy beliefs that modestly exceed an individual's capabilities allow for setting challenging, but attainable, performance goals. These performance goals help to grow skills, which in turn strengthen self-efficacy (Lent et al., 2002). Bandura (1999) writes that "the self-satisfaction derived from progress in mastering an activity serves as its own reward during the pursuit of goals" (p.28).

Self-efficacy beliefs are dynamic, increasing when factors may encourage a stronger sense of belief and decreasing when there are setbacks to improvement or progress (Lent et al., 2002). For female students, strong self-efficacy could encourage college major choices in traditionally male-dominated fields when confidence is high and plays a strong role in program persistence, allowing students to overcome adversity (R. A. Simon et al., 2015). Students may choose which challenges to pursue, how much time and energy to invest, and how long to persist in the face of difficulties based on the strength of their efficacy beliefs (Bandura, 1999).

Women's gender role beliefs can affect their learning and acceptance of male-dominated careers with Simon et al., (2015) writing that for female students, perception of self-efficacy and achievement goals were strong determinants of persistence and performance in STEM programs.

Yang & Carroll (2018) write that women in traditionally male-dominant STEM programs experience subtle insults, negative communication, and discrimination, termed microaggressions, which can lower self-efficacy. Those with high efficacy show greater resourcefulness when facing challenges and are able to manage their environment effectively and productively (Bandura, 1999). One way students can work to increase self-efficacy is through the use of goal setting and motivation and setting of expectations.

Goal Setting and Motivation

Goal setting provides a useful mechanism for finding out why students succeed or fail because it gives them the ability to focus on specific tasks. Evidence increasingly suggests that goals pursued by an individual create a framework for interpreting and responding to events that occur (Dweck & Leggett, 1988). Individuals' goals generally fall in line with personal capabilities and expected outcomes by those who set them with success or failure in reaching these goals having a direct effect on self-efficacy and outcome expectations (Lent et al., 2002).

Mastery goals may increase motivation, engagement, deep learning, and persistence, helping to buffer the negative effects of gender stereotypes (R. A. Simon et al., 2015). Setting personal challenges and then evaluating performance towards those challenges is a major component of personal motivation with goal setting itself leading to personal investment in an activity. The self-evaluation upon meeting those goals then leads to fulfillment (Bandura, 1999). Much like goal setting, the idea of motivation may offer reasons as to why students may hesitate or pursue challenges.

Motivation is the expectation that a given course of action will produce specific outcomes and those outcomes will provide value to the individual (Bandura, 1999). Dweck & Leggett (1988) describe two forms of motivation: the 'helpless' response, where students will avoid challenges and see a deterioration of performance in the face of obstacles and the 'mastery-oriented' response, where challenges are sought and there is continual maintenance of performance even through failure. Students who have a goal to prove their ability have weaker coping and resilience outcomes than those who set goals to improve their abilities. This efficacy belief can affect students' abilities to handle stress and challenges. Students who believe intelligence is fixed will set performance goals while those who believe intelligence is malleable and capable of growing will set learning goals (Dweck & Leggett, 1988). Those with high motivation can lower their stress and anxiety by managing their environment in positive ways (Bandura, 1999).

Simon, Aulls, Dedic, Hubbard, & Hall (2015) write that student persistence can be attributed to individual levels of self-efficacy and personal achievement goals as well as to perceived support from within the college and prospects for STEM career attainment. Broad & McGee (2014) write about Saint Mary's College in Indiana, which faced a crisis of perception among their female students who were hesitant to take computer programming courses. The college implemented a plethora of strategies to increase self-efficacy for females in Computer Science and Information Systems classes including developing woman-centered courses, embedding computer sciences and information systems in General Education courses, not requiring prerequisite courses for computer programming courses, allowing students to personalize projects, and focusing on creating supportive and collaborative environments campus-wide. These concerted efforts showed modest success with active, face-to-face recruiting, an especially effective factor in attracting female students to take computer programming classes (Broad & McGee, 2014).

Colleges have also worked to enhance their secondary school-to-college transition models to teach college-skills, emphasize classroom work, and ensure a campus-wide scale through learning communities. These small communities within STEM programs can help build student identity and allow for relational learning by providing a structure for interaction between students, faculty, staff, and STEM professionals (Carrino & Gerace, 2016). Mau (2016) reports similar findings when implementing informal support groups that can offer encouragement to students with the similar goal of increasing self-efficacy. Those with strong self-efficacy tend to choose majors and careers from a broad range of choices, work to prepare themselves for those careers, and tend to have stronger retention in those careers in the face of negative challenges (Bandura, 1999).

STEM Overview

While classes and programs focusing on STEM subject matter have been in the United States since the 1950's, historically the term "STEM" was conceived and popularized by the National Science Foundation in the late 1990s (Blackley & Howell, 2015). Annual federal appropriations for STEM education range from $2.8 billion to $3.4 billion, covering 254 programs in 15 federal agencies showing the tremendous importance of STEM subject matter in modern education (Granovskiy, 2018). This government support is directly tied to projections showing that jobs in STEM fields are growing while not enough workers will be adequately trained to meet this future demand (Blackley & Howell, 2015).

STEM project-based learning can enhance student problem-solving abilities, allow for application of complex knowledge in science, technology, engineering, and mathematics, and can increase student interest in these fields (Liu et al., 2014). While female graduates have reached parity with men for Science and Engineering degree completion, there are disproportionately smaller numbers of completers in highly-technical sciences, math, and engineering programs, which has led to lower numbers of females in these career fields (National Science Foundation, National Center for Science and Engineering Statistics, 2017). STEM programs have many different pathways, unique expectations, and varied outcomes, necessitating an understanding of how female students have persisted in each historically in order to find clues as to why they may not stay in these programs at a rate equal to men.

Characteristics of STEM Students

Female and minority students have a particularly difficult time entering into STEM majors. Females were awarded the majority of bachelor's degrees overall in 2016 at 58%, but in STEM fields females were awarded a lower percentage of bachelor's degrees than males, a pattern which was observed across all racial and ethnic groups ("Indicator 26: STEM Degrees," 2019). Women make up 42% of STEM degrees nationwide relative to their 49% share of the college population ("STEM Education Data and Trends," 2019). Underrepresentation of females in STEM starts in childhood and is affected by many factors including family, teachers, peers, culture, mentors, and societal pressures (Kahn & Ginther, 2017). The factors cited for fewer females in technical fields include lack of female role models, gender stereotypes, and less family-friendly flexibility in STEM careers post-college (Beede et al., 2011).

Broken down by ethnicity, whites earn 52% of all STEM degrees followed by Hispanics at 14%, African Americans at 12%, and Asian/Pacific Islanders at 6% ("STEM Education Data and Trends," 2019).Women, minorities, and students from low-income backgrounds leave STEM programs at the highest rates (Smith et al., 2018). Mau (2016) finds that 38.4% of STEM students are first-time freshmen, compared to 29.4% non-first-time freshmen, and that those who declared a STEM major tended to be younger, had higher standardized test scores, GPA scores, and had earned more credit hours than those in other majors.

In STEM careers females are less likely to pursue, and more likely to leave jobs, where work time and job requirements come at the cost of family considerations, with many finding that STEM careers are incompatible with these family goals (Kahn & Ginther, 2017). For STEM graduates, men lead females for work occupations such as computers, mathematics, and statistics, engineering, physical sciences and those related to science, only finding comparable career attainment in biological, environmental and agricultural sciences, and social sciences (Bureau, 2014).

Gender-related Issues in Technical Education

Kugler et al. (2017) write that society sends coded messages that STEM fields are masculine, and that, in a rush to solve this issue by advertising to prospective female students, colleges have instead reinforced more strongly that STEM is not a field for women. This societal and perceptive gender bias adds an additional barrier to STEM programs looking to increase female students, especially in those programs where representation is already low (Yang & Carroll, 2018).

Dweck & Leggett (1988) found external factors, such as lower socioeconomic status, could lead students to have avoidance goals where their central concerns were to avoid negative outcomes, not to enhance their competencies in a subject area. Being female in a strongly gendered male environment could, conceivably, lead to similar avoidance goals.

These socio-cultural norms and gender stereotypes further undermine female students participation in STEM programs by placing an extra barrier to enrollment and ultimate program completion that male students do not have to contend with during their educational careers (R. A. Simon et al., 2015).

Mau (2016) writes that females continue to be employed in strong numbers in fields which are considered traditionally for women such as Nursing and K-12 teaching but not in strongly technical STEM fields. Perception must change to reflect the positive elements of STEM. Female student population is high in fields such as Neurobiology, Environmental Biology, and Biology of Global Health (Beede et al., 2011). Focusing recruitment campaigns on these fields, and others that show rates of growth, could help change the conversation for interested students and ensure a sense of belonging from the first day. Changing culture and perception around STEM is important to get more females into these majors (Kugler et al., 2017a). This cultural change will need to include a vision for incoming female students that ensures they feel comfortable and supported by the program and overall college.

There are also issues for female students in how they perceive themselves in STEM programs. High-technology majors and occupations, such as Virtual Reality, have shown lower academic success rates among female students as these majors tend to have particularly strong male enrollment and male teachers (Ausburn et al., 2009). Females were also found to be more adversely responsive to negative feedback than men in specific technology environments, including grades received, where men made up the majority of the class (Kugler et al., 2017a). Starr, Anderson, & Green (2019) suggest extra attention and encouragement from faculty may be needed for females in strongly gendered learning situations, especially when they involve high-level technology.

The self-perceptions of female students as being less capable or not belonging in highly-gendered and high-technology majors could lead to a self-fulfilling prophecy that they are naturally not as adept at the technology as male students. Ausburn et al. (2009) writes that "this notion of technology self-efficacy raises the possibility that gender differences…may be related to different experiences and perceptions of digital technologies" (p.61). Starr et al. (2019) found success for female students by offering a self-intervention in these types of courses. By exposing students to the material, technology, and role models early in their program experiences students build identification with the course and showed significantly stronger persistence than those with no prior experience (Starr et al., 2019).

Career and Technical Education

Career and Technical Education would seem to be a natural fit with STEM, incorporating subjects with a particular focus in technology, math, and science with training for high-demand career fields (Bernardino & Seaman, 2011). CTE programs are run at the state-level but funded by federal legislation called The Perkins Act. This legislation mandates that programs are developed, and continually monitored, so they serve career areas that are deemed "high need occupations" ("Reauthorization of Carl D. Perkins Vocational and Technical Education Act," 2007). In the United States, 75% of all comprehensive high schools offer several courses in one or more specialized labor market preparation programs with linked college credits and courses ("What Is CTE?," 2016). In addition to comprehensive high schools, vocational education is offered at secondary vocational centers, community colleges, and technical centers (Whiteman, 2004).

Career and Technical Education carries an outdated image by students, parents, and the general public as a program with little academic rigor and as a pathway to low-skill jobs (Bernardino & Seaman, 2011). Starting with the early days of student tracking, pre-selecting students for individual majors and subject educational pathways, vocational education has often been considered the route for low-achieving, non-college bound students (Palmer & Gaunt, 2007). The image of CTE has evolved in United States with 94% of high school students receiving at least one CTE credit before graduation and with graduation rates for CTE high school students at 90% compared to 75% for traditional students (Jacques & Potemski, 2014). There are 140,000 CTE teachers in the United States and they teach in all of the high-priority STEM fields as mandated by the federal government (Jacques & Potemski, 2014). CTE teachers now make up 12% of all high school teachers and most, 81%, teach in traditional comprehensive high schools, not technical schools, which force students to travel for part of their school day (Hensley, Ottem, & Levesque, 2017).

The United States Department of Education (2018) reports that the number of students as a whole graduating high school has continued to rise, hitting 82% in 2013-2014, though only 66% attend college. The Pennsylvania Department of Education (2018) reports that in Pennsylvania, the high school graduation rate is 70%, well short of the national average, and only 65% when narrowed to students graduating on-time, within a four-year window. As an educational model for helping students graduate from high school and attend college, Career and Technical Education has been shown to be highly effective with a high school program completion rate of 90.18% in Pennsylvania, compared to an average nationwide academic graduation a rate of 74.9% (“Pennsylvania Department of Education, Career and Technical Education,” 2018).

The National Association of State Directors of Career Technical Education (2012) writes that CTE increases the opportunity for students to gain the knowledge, skills, and credentials needed to secure careers in growing, high-demand skills. The top five career clusters in total employment by 2018 will be Business, Marketing, Hospitality, Health Science, and

Transportation, all highly dependent on STEM fields of study (Sargent, 2014). There is vested interest from the federal government, through the Perkins legislation, and through state governments which administer mandates of the legislation, to show that CTE training can lead to high-demand jobs and increase students entry into the STEM college pipeline (Sublett & Plasman, 2017).

CTE offers a secondary education training ground for the STEM fields and, in many cases, dual enrollment so that the transition between CTE in high school and STEM in college includes transferable credits, college skills training, and time on campus. Ausburn et al. (2009) suggest that CTE teachers be specifically trained and knowledgeable about female student perceptions in male-dominant classes so that extra care, attention, and training can be given to female students. Duffy (2002) expands this notion by adding academic advising, pre-college counseling, financial aid planning, study skills workshops, and assessment testing to CTE programs to achieve the highest probability of student program completion. Belser et al. (2018) found that career development programs have shown success when applied to targeted populations of students. Smith et al. (2018) build on that research, writing that “rigorous high school coursework and academic preparation are key predictors of students declaring and persisting in a STEM major” (p.22).

Dual Enrollment

When students take STEM courses in high school they perform better in STEM college courses and are more likely to graduate with a STEM major (Smith et al., 2018). Dual enrollment programs offer students the benefit of taking high school classes that have value at a partner college as well as the opportunity for higher education bridge-skills such as interaction with college faculty and mentors, classes on college campuses, and use of technology and facilities that is consistent throughout the program. These programs help students to develop math, science, and technical skills along with academic skills, demonstrating the potential benefits of college and exposing them to the expectations of postsecondary education (Karp & Hughes, 2008).

CTE students who participated in dual enrollment courses had better educational outcomes than their classmates who did not participate. After three years of college, dual enrollment students had grade point averages 0.24 points higher than non-dual enrollment students (Karp & Hughes, 2008) and also made faster progress toward college credentials. Zinth (2014) finds students in CTE dual enrollment programs to have stronger success in earning a high school diploma, enrolling in a bachelor's degree program, and in enrolling full-time in a college than their academic-only or non-dual enrollment peers.

The Perkins legislation draws a balance between helping individual students attain program completion and ensuring that these programs will translate to work after school, which Meeder (2008) links to Congress' original Perkins goal "to keep the United States competitive" (p.7). The prospect that students completing dual enrollment CTE programs will have a degree, certificate, or training in a high-demand field makes this study uniquely important. Bastedo, Altbach, & Gumport (2016) write that as graduates leave college campuses, an overabundance of STEM jobs offers the opportunity for students to seize brand new positions where competition hasn't reached critical mass, giving STEM students a real advantage in the market.

Orientation Programs

Choice of major should be looked at as a dynamic process, constantly changing for students as they learn about the field and their interest and abilities in the major (Kugler et al., 2017a). This fluidity has led to the rise of long-term transition programs at colleges to serve students well beyond freshman year as they provide depth and breadth in areas that can help to improve student success on campus (Habley, Bloom, & Robbins, 2012). Designing an orientation program offers colleges and their individual programs a way to work together to increase student success and retention by giving students needed skills they may not have learned during secondary education (An & Taylor, 2015).

Kerby (2015) looked at the transition between high school and college and found it to be a process of de-socialization and socialization. Much like the high school experience, female students can feel alienated when not socialized, affecting whether they will persist in school. Stronger connections between guidance counselors at secondary schools and advisors at local college campuses could help increase student self-efficacy, a major psychosocial predictor of student retention (Habley et al., 2012). Colleges could also increase their outreach to classes of secondary students to explain services, the application process, and financial aid, helping to demystify the process for high school students while increasing comfort with the initial college transition.

Tinto (1999) strongly advocates for building learning and cohort communities for students at school. Habley, Bloom, & Robbins (2012) recommend a structure for an effective orientation program, which should include ways "to help new students succeed academically, to assist students in their adjustment to and involvement with college, to assist parents and other family members to understand the collegiate experience, and to provide the college with an opportunity to get to know incoming students" (p.317). Student social structures develop through the orientation process during which students are able to find familiarity with the program and their peers. One structural way colleges can formalize and strengthen these networks is through learning communities.

Learning Communities and Caring Educators

STEM learning communities can help to recruit, develop, and retain students in STEM disciplines. They have been found to increase student academic success, program completion, and post-graduation participation in STEM career fields (Carrino & Gerace, 2016). Marrero (2016) writes that “individual learning is associated with social relationships and interactions that effect educational outcomes through the emphasis that the individual and the environment are linked” (p.180). Learning communities may offer a way for the individual and the environment to be linked within the structure of the college but may not be attainable for commuter schools or community colleges with no option to live on campus. Antinluoma, Ilomäki, Lahti-Nuuttila, & Toom (2018) write that creating a school community does not have to be formalized and can include an emphasis on professional collaboration, creating a culture of collegiality, and constant professional development of instructors who can meet the needs of a diverse population of students.

Instructors serve as the main touchpoint for many students on college campuses and can factor into the complex formula of what determines student persistence (Murphrey, Miller, Harlan, & Rayfield, 2011). The prevailing thought to change the male-dominated STEM perception was to hire more female faculty in STEM fields, but Kugler et al. (2017) find that an increase in female faculty does not seem to attract female students to STEM programming. McNair, Albertine, Cooper, Major, & McDonald (2016) throw out the idea of teacher gender as important in enrollment and retention and focus instead on creating a “caring educator” where faculty and staff act as mentors within their sphere of influence. This should ideally include faculty as diverse as their students as well as ongoing training so that they, and other point persons for students, have effective knowledge of campus systems and can provide useful guidance.

Simon et al. (2015) make the case for autonomy-supportive teachers who make students a part of the classroom decision-making process, are flexible with lesson pacing, and build on prior knowledge, finding that students with these teachers in STEM programs can predict stronger motivation and academic performance. Ausburn et al. (2009) suggest that STEM teachers be specifically trained and knowledgeable about these findings so that extra care, attention, and training can be given to female students when using highly complex technology. This can be introduced during the orientation process and then tailored to the needs of students as they assimilate into their major programs. College administration can combat gender inequality on campus by working to provide evidence-based training and workshops for students and professional skills coaching for students (Yang & Carroll, 2018).

Smith & Zhang (2009) find that college professors are consistently perceived as a helpful or very helpful factor facilitating the transition. This should not be surprising as students develop close relationships with their teachers in high school, seeing them on a daily basis compared to guidance counselors, so their expectation of the same relationship once on campus would be natural. Having faculty at the first-line for surface questions and resources could help ease students into the college experience, acting as an early warning or prevention system (Habley et al., 2012). Faculty could also help direct students to the next level of supports when necessary and otherwise follow-up on the initial student issue.

Real-world Partnerships and Internships

Allowing female students to build relationships with strong female role models provides a support system outside of the college program and cohort (Davis, 2014). Successful outreach programs signal that females in STEM fields can balance work and personal demands (Davis, 2014). Fighting against preconceived notions that high-technology programs and fields are for males only must include assurances and reinforcement from the professional fields that depend on CTE and STEM programs for well-trained workers. Colleges must develop partnerships with employers that include curriculum development, internships, and current industry training and technology (Fain, 2017).

According to Davis (2014) females in underrepresented STEM fields need to see successful female role models that look like themselves repeatedly. Internships provide one way for female students to interact with working professionals in real-world environments outside of the classroom. Tinto (2012) writes of the need to involve and engage students in all aspects of learning and that "such engagements lead not only to social affiliations and the social and emotional support they provide, but also to greater involvement in learning activities and the learning they produce" (p.3). This focus should also help ensure that students know about hire rates and the high wages in STEM fields. Prospects of higher earnings could bring women to male-dominated majors, but Kugler et al. (2017) warn that attracting women to fields where they are under-represented will also require progress on equal pay for workers initiatives.

Careers in STEM Fields

Kahn & Ginther (2017) found that male dominance in the workplace itself may not be enough to explain poor female persistence in STEM fields, asserting that a collection of factors including poor childcare options in the workplace and having less time to commit to work once they have children are much stronger factors for choosing non-STEM fields. In the United States, women make up 48% of the workforce but only 24% of those employed in STEM fields (Smith et al., 2018). Zheng et al. (2016) report that in 2014 there were 4.8 million jobs in STEM fields, with an increase of 26% from 2004 to 2014. The largest share of STEM jobs are within computer science and math fields, at 47%, followed by engineering at 12% (Beede et al., 2011).

Women who graduate with a STEM degree tend not to persist through STEM careers, instead transferring to non-STEM and generally non-management-level work (Kahn & Ginther, 2017). Females with STEM degrees are less likely than males to work in STEM overall with particularly low numbers in engineering compared to males. Females outpace males in occupations in fields such as education and health care fields (Beede et al., 2011). Females are far more likely than men to cite “family responsibilities” as a reason for not choosing a science or engineering field (National Science Foundation, National Center for Science and Engineering Statistics, 2017). Kahn & Ginther (2017) found that females with children were less likely to pursue a STEM career, be promoted within a STEM field, and move on to a better job in a STEM field, such as in a management role.

Making students aware of STEM career earnings, compared to non-STEM careers, was found to encourage women to enter STEM fields at higher rates than high school preparation or by increasing the number of female faculty (Card & Payne, 2017). The largest STEM-wage earning capacity belongs to those who both major in STEM and work in a STEM field, earning 29% higher hourly pay than those outside of STEM. This pay disparity shows the value of keeping female students persisting through graduation and also ensuring that they are motivated to apply to STEM career opportunities (Beede et al., 2011).

CHAPTER THREE: Methodology

Prior research has shown that female students tend not to apply to, or successfully persist-through, STEM majors which may lead to the highest paying careers (Beede et al., 2011). There is no consensus cited by past studies as to why female students are not persisting in STEM programs in rates as high as males, but the research does point to a collection of smaller factors, such as less experience with technology growing up, poor recruitment to STEM in secondary education, and lack of female role models, which may exacerbate low feelings of self-efficacy in male-dominated college programs leading female students to drop out or transfer to other majors (Simon, 2016).

While there are studies which highlight reasons for female students drop out of STEM classes and programs, there is a gap in the literature on why they may *persist* in these programs. This study asked students reasons for their persistence in their STEM programs, looking to find correlation between persistence and encouragement through technology use at an early age, taking CTE or STEM classes in high school, teacher encouragement, resources available on college campuses as well as the prospect of a well-paid STEM career. This study also sought to validate whether self-efficacy and social cognitive theory have an impact on persistence and STEM career attainment. This chapter includes a description of the research design, instruments used, a breakdown of the participants, and the setting where the study took place as well as an overview of how data were collected and analyzed.

Theoretical Framework and Research Design

The study used a mixed methods approach to find sources of persistence for female students enrolled in STEM programming at the targeted college. A mixed methods approach included the collection of both qualitative and quantitative data, which were both integrated in the final analysis. This study includes research questions that are both qualitative and quantitative in nature, necessitating a mixed-methods approach to fully address them (Creswell & Creswell, 2018). An explanatory sequential design was used as two phases were employed in the study; an initial survey followed by collection of supplemental data through interviews (Leedy, Ormrod, & Johnson, 2019). The first phase helped to answer the following research question:

1. What keeps students, and in particular female students, persisting through successful completion of STEM college programs in a community college?

In this stage, subjects were asked to answer a researcher-developed electronic survey inquiring about student exposure to technology at home, their high school experience with CTE and STEM, and their current STEM college program (see Appendix C). A second series of questions asked students about their feelings of persistence in their current STEM program, whether they will transfer to a four-year program in STEM, and if they plan to pursue a STEM career after graduation. With these two lines of questioning the independent variable is the encouragement they received, and the dependent variable is whether they plan to persist in their college program. A quantitative approach for this question allowed for the conversion of answers into data, which were then correlated using a Pearson Product Moment Correlation Coefficient (r) using SPSS software.

The second phase helped to answer the following research questions:

2. What are the lived experiences of female students in STEM community college programs?
3. What are the “critical points” where female students tend to persist in STEM college programs?

4. How have the lived experiences in secondary education STEM and CTE programs influenced student persistence toward successful completion of STEM community college programs?

Each of the preceding research questions was best answered by an in-depth interview of students (see Appendix E). Interviews gave the researcher an opportunity to ask students more detailed questions about moments of encouragement and persistence throughout their school careers. Answers were then coded and then scanned for related themes among subjects, which help to answer research questions 2, 3 and 4 (see Appendix G).

Leedy, Ormrod, & Johnson (2019) write that a phenomenological study works to understand perceptions in a given scenario. This type of qualitative study is appropriate in this case because the in-depth interview looked to find what female students experienced while enrolled in college STEM programs, what specific points in their program they classified as particularly important to their persistence, and whether they believed high school CTE and STEM tracking helped them to persist. A mixed-methods approach helped to ensure triangulation, as data were gathered from survey responses and multiple interviews. It was hoped that multiple sources of data would converge on a few particular themes confirming credibility of the study's findings (Creswell & Creswell, 2018).

Setting

The study setting was a community college in southeastern Pennsylvania. In 2018 the college enrolled 11,480 students with a student to faculty ratio of 18 to 1. Of enrolled students, 67% were part-time while 33% were full-time; 66% of the college community was aged 24 and under and split 57% female and 43% male. For cultural identification, 59% of students identified as White, 14% Black, 6% Hispanic, and 6% are classified as Asian. All students reported their residences as in-state ("The Integrated Postsecondary Education Data System (NCES)," 2018). Of the first-time students who returned for studies the following fall, the college retained 65% of its full-time students and 48% of its part-time students. The overall graduation rate was 21% with a 15% transfer-out rate ("The Integrated Postsecondary Education Data System (NCES)," 2018). For full-time degree or certificate-seeking undergraduates the college saw 26% of its first-time students and 24% of non-first-time students receive an award within 8 years. Part-time degree or certificate-seeking undergraduates saw 12% of first-time students and 14% of non-first-time students receive an award within 8 years ("The Integrated Postsecondary Education Data System (NCES)," 2018).

Participants

The survey was given to fourth-semester students in the Department of Science, Technology, Engineering, and Mathematics and in Communications. The survey was opt-in, voluntary, and available on both paper and secure website link to help maximize the pool of subjects. The goal was to have at least 60 participants, 30 female and 30 male subjects, complete the survey so that responses for each subgroup could be compared and to ensure validity (Creswell & Creswell, 2018). There were no limitations on subjects' given sex, age, ethnicity, or educational background. Demographic data were collected to allow the researcher to describe characteristics about the sample.

Students self-selected whether they were interested in participating in a follow-up interview by filling out an optional "Interview Consent" form (see Appendix D) after the survey was completed by paper or at the end of the electronic survey. Eight students' "Interview Consent" met the criteria for female, fourth semester, STEM students above the age of 18 at the targeted college.

The college's 2018 program completion awards break down into Communication Technologies (11), Communication (32), Computer Science (61), Engineering (21) and Game and Media Design (2), which allows for a potential pool of 127 students ("The Integrated Postsecondary Education Data System (NCES)," 2018). This number only includes those who were awarded degrees so the number of likely students who are in programs is presumed much higher as students transfer, take time off, or have otherwise not completed.

This was considered a generally low-risk study with no protected classes in the subject pool and a voluntary, electronic survey in the first phase of questioning. There was potentially sensitive material discussed during the in-depth interviews, so subjects were given copies of the questions ahead of time, informed that they could withdraw at any time with no penalty from the interview, and that the interview was completely voluntary. There were likely no long-term risks to the subjects of this study.

Instruments, Reliability and Validity

An explanatory sequential design was used with an initial quantitative survey given to participants in the first phase and an in-personal, qualitative interview in a phase two follow-up (Leedy et al., 2019). According to the National Science Foundation, National Center for Science and Engineering Statistics (2017) the number of females in particular STEM career fields can differ based on pre-college education, whether STEM courses were taken in college, and in overall educational attainment, making it necessary to construct a survey that asked sample student questions in those three areas. A second set of questions asked about their plans to persist in the program in three separate ways: program completion, degree completion, and plans to pursue a career in STEM.

When constructing the survey and interview questions, it was necessary to take into account Yang & Carroll's (2018) suggestion that no questions be perceived as sexist or make participants uncomfortable, there is neutral gendered language used, and that female participants are not singled out with the intention of researcher help, which could lead them to feel they are less capable. An expert panel reviewed the surveys in this study for validation including Dr. Christine Cavanaugh, Dr. Carolyn Dumaresq and Dr. Debora Broderick, all experts in educational research.

Initial Survey

In the first phase, a correlational study was used to determine whether variables are associated with differences in other variables (Leedy et al., 2019). In this study, the dependent variable is a student's decision to persist in a STEM college program, termed the "persistence score," with the independent variables being the specific experiences in the program, history with technology, and CTE background in high school; together these are termed the "encouragement score." An electronic survey was provided asking students to answer questions using a Likert scale weight from 1-5 points based on agreement. A Pearson Product Moment Correlational Coefficient (r) was then computed to determine the strength and direction of the relationship between the two variables. An identical paper survey was prepared if there were not enough electronic responses but it was not needed.

Interviews

In the second phase, a phenomenological approach was used to look for answer patterns and commonalities from three in-depth interviews. For those participants who agreed to an in-person interview, qualitative questioning was conducted because this type of research is used to answer questions about the complex nature of phenomena with the purpose of describing and understanding the phenomena from the participant's point of view (Leedy & Ormrod, 2005). Answering questions about self-efficacy within a college program requires a qualitative approach as the study looks to find students in their natural setting and tries to interpret phenomena by the meanings people bring to them, in this case through an in-person interview (Denzin & Lincoln, 2005).

Data Collection Procedure

The initial electronic survey was emailed to fourth semester students in the School of Science, Technology, Engineering, and Mathematics by the school's Dean with a summary of the study provided by the researcher. The electronic survey was active for two weeks and data were collected via the Survey Monkey online platform in the spring 2019 semester. Before initiating the study, students had to read over the "Survey Consent Form" (see Appendix B) and opt-in to take the survey.

The STEM Dean and primary researcher discussed the possibility of not having enough participants complete the electronic survey, so permission was given to hand out paper surveys at the beginning of fourth semester STEM courses. If needed, paper surveys would have been provided to an NIH-certified research assistant who agreed to introduce the research, explain the purpose and process for participation, note that the survey was voluntary, and that there would be no impact or relation to the course where the survey was given. The research assistant would be responsible for collecting consent forms, collecting completed surveys, and collecting consent to interview forms which were placed in separate, sealed envelopes. The research assistant would hand-deliver the sealed envelopes directly to the primary researcher.

Twenty-two "Requests for interview" forms were returned indicating interest for an in-person interview. Twelve met the criteria for interview including that they identified as female, were STEM majors, and over the age of 18. Potential interview subjects were contacted by the primary researcher by email and asked to use an internet link embedded within the email to confidentially schedule a time to meet through the online program Calendly. Eight students signed up for a day and time with three showing to participate in the interview. The in-depth interviews occurred two weeks after the closing of the electronic surveys. All interviews were recorded at the library of the targeted campus as a neutral space where there was less chance of a power dynamic between researcher and subject, for convenience for students, and to allow a measure of privacy outside of the physical space of the College of STEM.

The primary researcher coded each participant with a name for the transcription process. Using Microsoft WORD, the researcher coded, looked for common themes among interviews, and completed an "Interview Themes Chart" (see Appendix G). Answers were grouped and tabulated to find five prominent themes. These themes were then compared to data from the quantitative surveys to find consistencies.

Debriefing after the study's completion involved a full explanation of the study, the results found, and conclusions reached, as well as contact information for Immaculata University and an assurance for those who participated in the in-depth interview that audio footage was destroyed two weeks after recording and that names were changed on written transcriptions to protect subjects' identity.

Data Analysis and Interpretation

Research Question 1

Research question 1 required an electronic survey so that comparisons could be made between female and male subgroups for persistence and encouragement (Leedy et al., 2019). Survey question 6 was scored from 1 to 5 on a Likert Scale, tallied, and then divided by the total number of questions to create a mean score, was termed an “encouragement score,” for each participant. The encouragement score question included specific types of encouragement that were found in the literature review that may affect persistence in students including use of technology growing up, STEM in high school, college program teachers, administration, campus services, and cohort.

Survey question 7 was scored from 1 to 5 on a Likert Scale, tallied, and then divided by the total number of questions to create a mean score, what will be termed “persistence score,” for each participant. These questions focused on whether students planned to continue and complete their STEM program and major at the targeted college, transfer to a STEM program at a four-year college, and pursue a STEM career after graduation. A Pearson Product Moment Correlational Coefficient (r) was completed to see the strength and direction of the relationship between the two variables. A scatterplot was constructed to diagram whether there was a positive or negative correlation, whether this correlation is linear or scattered which will indicate the strength or weakness of their relationship, or whether there is no correlation.

Research Questions 2, 3 and 4

Research questions 2, 3 and 4 required more in-depth probing of participants through open-ended questions using an in-person interview. There are numerous methods that could be used to identify common themes in interviews. Coding was chosen in this case because it allows for the construction of preliminary categories that can then be visualized in useful ways by the researcher (Leedy et al., 2019). The researcher reviewed the interviews and created exact transcripts (see Appendix F). On subsequent readings the researcher then isolated common themes for each interview and graphed them by category to visualize commonalities among the three interviews (see Appendix G).

Limitations

Surveys were targeted to students in fourth semester courses within the STEM college though responses may include students who were taking advanced classes for majors outside of STEM. Sophomores in the spring semester were chosen because they have had the most amount of time possible in each STEM program before they must graduate with an associate degree or transfer to a four-year program. Data on the surveys, such as likelihood to complete the program and enter into a STEM career, were self-reported and likely not fully accurate as to what the final academic outcome may be for each student.

Interviews were conducted on a voluntary basis with 3 students appearing out of a starting total of 22 who provided contact information after the electronic survey. The type of student who participated in these interviews may not be fully indicative of the majority of STEM majors. They may have higher self-efficacy and confidence to have the courage to appear and may not fit the demographic of a typical student in the 18-24 age range at the college. This particular limitation indicates a space for further research focusing on interviews with students in the dominant age range at the college.

Though this study stopped at STEM program completion, the ultimate goal of the research is to ensure that female students also find work after graduation in related fields to their study, a piece of research that would not be available by the completion of this study. Issues of defining successful completion of a program are also inherent in this study as STEM programs can be completed in many different ways such as finishing state required hours, a final test, final project, or by earning an associate degree, apprenticeship, or certification. For the purposes of this study, a degree, award, certificate, or plan to transfer to a STEM major at an articulated four-year college were considered program completion.

Summary

This study employed a mixed-methods explanatory sequential design. In the first phase, surveys collected quantitative data about demographics, encouragement, and persistence of males and females enrolled in a STEM college program. Survey data were computed using a Pearson Product Moment Correlation (r) to determine whether encouragement and persistence of students were correlated. The second phase used in person interviews to gain more clarification, detail, and insight from female students about their experiences in high school and the targeted college's STEM program as well as to understand the strength of their feelings of persistence to complete the program, go on to four-year degree completion, and eventual entry into a STEM career field.

CHAPTER FOUR: Findings

The purpose of this study was to understand what motivates female students to persist in STEM college programs. This chapter presents the findings from a survey designed to gauge persistence in students, roadblocks they may have faced, and plans for program completion. Interviews were also conducted with participants to gain a deeper understanding of what types of encouragement may be most effective in promoting STEM program completion.

Surveys were distributed in the fall 2019 semester by email to students in 34 second-year STEM courses, covering 86 sections, including classes in Anatomy and Physiology, Genetics, Calculus, Digital Systems, Principles of Physics, Network Hacking, Game and Simulation Programming and Advanced 3D Modeling. A total of 84 surveys were started, 2 subjects did not wish to grant informed consent, and 69 subjects completed surveys.

The following tables shows the survey responses of the 69 students for questions of encouragement and persistence.

Table 4.1

Student Survey Responses for Encouragement

Statement	Responses						
	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Total	Median
Growing up I was encouraged to use technology by my family and friends.	23.19% 16	42.03% 29	17.39% 12	14.49% 10	2.9% 2	69	3.68
I was encouraged to use technology in high school.	28.99% 20	50.72% 35	5.8% 4	7.25% 5	7.25% 5	69	3.87
My high school prepared me for college.	17.65% 12	33.82% 23	20.59% 14	14.71% 10	13.24% 9	68	3.28

My high school prepared me for a major in STEM.	16.18% 11	19.12% 13	25% 17	23.53% 16	16.18% 11	68	2.96
I was encouraged to take STEM classes in middle and high school.	18.84% 13	26.09% 18	14.49% 10	24.64% 17	15.94% 11	69	3.07
I was encouraged by my high school advisor to take STEM classes in college.	13.04% 9	15.94% 11	28.99% 20	26.09% 18	15.94% 11	69	2.84
I was encouraged by my college advisor to take STEM classes at MCCC.	14.49% 10	24.64% 17	37.68% 26	7.25% 5	15.94% 11	69	3.14
My STEM college professors encourage me to succeed in class.	50.72% 35	37.68% 26	5.8% 4	4.35% 3	1.45% 1	69	4.32
I have found STEM college administrators helpful and supportive (Dean, Department Head, etc.).	24.64% 17	26.09% 18	37.68% 26	5.8% 4	5.8% 4	69	3.58
My STEM class cohort provides me with support when I struggle.	17.39% 12	37.68% 26	34.78% 24	7.25% 5	2.9% 2	69	3.59
STEM careers pay better than many non-STEM fields.	44.93% 31	27.54% 19	21.74% 15	5.8% 4	0% 0	69	4.12

Table 4.2

Student Survey Responses for Persistence

Statement	Responses						
	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Total	Median
I plan to complete my STEM-major college program.	70.15% 47	13.43% 9	8.96% 6	4.48% 3	2.99% 2	67	4.43
I plan to graduate with a STEM degree.	73.13% 49	11.94% 8	8.96% 6	2.99% 2	2.99% 2	67	4.49
I plan to enter a STEM career field.	74.63% 50	16.42% 11	4.48% 3	2.99% 2	1.49% 1	67	4.6

Survey respondents' demographics consisted of 35 females (50.72%), 32 males (46.38) and 2 who chose not to identify their gender (2.9%). The data for those choosing not to identify gender were omitted from the study because of a small sample-size. While surveys were targeted to courses generally taken during the students' second year at the college 6 (8.7%) reported their standing as first semester, 19 (27.54%) as second semester, 9 (13.04%) third semester, 18 (26.09%) fourth semester, 6 (8.7%) as fifth semester and 11 (15.94%) reported other, with answers varying from 6^{th} to 10^{th} semester, "ongoing," "my last year" and "I'm a part-time student."

Age was reported by 44 students (64.71%) as 18-24 years old, 8 respondents (11.76%) were 25-43, 11 (16.18%) were 35-44, 3 (4.41%) were 45-54, and 1 respondent (1.47%) each reported 55-64 and 65 and older. The breakdown of STEM majors was 29 (42.03%) in Science, 11 (15.94%) in Math, 12 (17.39%) in Engineering, and no responses for Communications. Other was chosen by 17 respondents (24.64%) and included answers of "Health," "PTA (Pre-

Technical),” “Nursing,” “Arts,” “Non-degree seeking,” “No Major,” “Computer Science,” “Healthcare,” “I mix between Technology and Math,” and “I don’t know.”

Tables 4.3 to 4.6 shows the demographics of respondents to the survey including current semester, major, gender, and age.

Table 4.3
Demographics - Semester

Participant Semester Enrollment	Percentage	Participants
First Semester	8.70%	6
Second Semester	27.54%	19
Third Semester	13.04%	9
Fourth Semester	26.09%	18
Fifth Semester	8.70%	6
Other (please specify)	15.94%	11

Table 4.4
Demographics - Major

Participant College Major	Percentage	Participants
Science	42.03%	29
Technology	15.94%	11
Engineering	17.39%	12
Math	0.00%	0
Communications	0.00%	0
Other (please specify)	24.64%	17

Table 4.5
Demographics - Gender

Participant Gender Identification	Percentage	Participants
Male	46.38%	32
Female	50.72%	35
Other	2.90%	2

Table 4.6
Demographics - Age

Participant Ages	Percentage	Participants
Under 18	0.00%	0
18-24	64.71%	44
25-34	11.76%	8
35-44	16.18%	11
45-54	4.41%	3
55-64	1.47%	1
65+	1.47%	1

Results of Surveys

Surveys were divided into three sections. The first section, question 2, asked for demographic information including semester, STEM major, gender, and age. The second section, question 6, contained 11 statements related to encouragement using a Likert scale. These statements looked to cover technology use in family life outside of school, high school support, STEM program experience in college, and STEM career expectations. The third section, question 7, offered 3 statements related to persistence, using a Likert scale, covering 3 unique ways that students could plan to persist: complete the current STEM program, graduate with a STEM degree, and enter a STEM career field. There was also a final open-ended question, question 8, asking "what factor do you think encourages you to persist toward degree completion in a STEM field?"

Encouragement and Persistence Scores

To identify an encouragement and persistence score, a combination of questions was tallied to address these specific items. Statements for question 6 were totaled using a Likert scale with 5 for strongly agree, 4 for agree, 3 for neither agree nor disagree, 2 for disagree, and 1 for strongly disagree. Totals were then divided by 11, the number of statements in the question, for a mean score, which is called the "encouragement score." Statements for question 7 were totaled using a Likert scale with 5 for strongly agree, 4 for agree, 3 for neither agree nor disagree, 2 for disagree, and 1 for strongly disagree. Totals were then divided by the number of statements, 3, for a mean score, which is called the “persistence score.”

Female participants’ encouragement score was calculated as a 3.38 and persistence score as a 4.60. Male participants’ encouragement score was calculated as a 3.65 and persistence score as a 4.45. The standard deviation for males around the persistence score mean is particularly high at 1.01891. This could be due to a sampling error as this particular question had minimum answers of 1.00 and maximum answers of 5.00 which is not typical of other questions in the survey.

The SPSS descriptive statistics output for encouragement and persistence scores of male and female students can be seen in table 4.7.

Table 4.7

Descriptive Statistics

gender		N	Minimum	Maximum	Mean	Std. Deviation
1.00 Female	Encouragement Score	35	1.73	4.82	3.3829	.68889
	Persistence Score	35	2.33	5.00	4.6095	.72077
	Valid N (listwise)	35				
2.00 Male	Encouragement Score	32	1.73	4.91	3.6420	.65063
	Persistence Score	30	1.00	5.00	4.4556	1.01891
	Valid N (listwise)	30				

Open-ended Responses

One open-ended question was included in the survey to assess what students believed most encouraged them to stay in their STEM college program. A review of the responses for both males and females found uniqueness among responses when separated by gender.

Female responses tended to cluster around the broader themes of STEM employment and self-determination. Examples of STEM employment responses included; “guaranteed jobs,” “It’s exactly what I want in my career,” “stable job with good pay,” and “I am excited about my field and I know I will make good money and have good working hours.” Self-determination answers included; “my own personal goals to succeed at everything I do,” “my general love/passion for biology,” “self-motivation,” “the thrill of seeking answers to real-world applications and the support group of like-minded students fuels my persistence in completing my STEM degree,” and “working towards a future I can be proud of that allows me to be a part of something bigger than myself.”

Male responses clustered around the minor theme of STEM employment opportunities and the major theme of personal and professional satisfaction. Examples of STEM employment opportunities included; “I love working with technology and it’s a growing field with plenty of opportunities,” “the quality of jobs available,” and “knowing that I will have a solid path to success after graduation and have a promising future ahead.” The largest theme for males was personal and professional satisfaction with answers including; “the constant learning required, as well as I personally really enjoy the field,” “I enjoy it. When I am working on projects for class I do not find it as work, but an activity to complete,” “the desire to work in a field where I can use my knowledge and passion each and every day to help others,” “interest and passion,” “I believe this is the path I'm supposed to take," and "to learn and understand a complex field to the best of my ability, and to have a career doing something I enjoy."

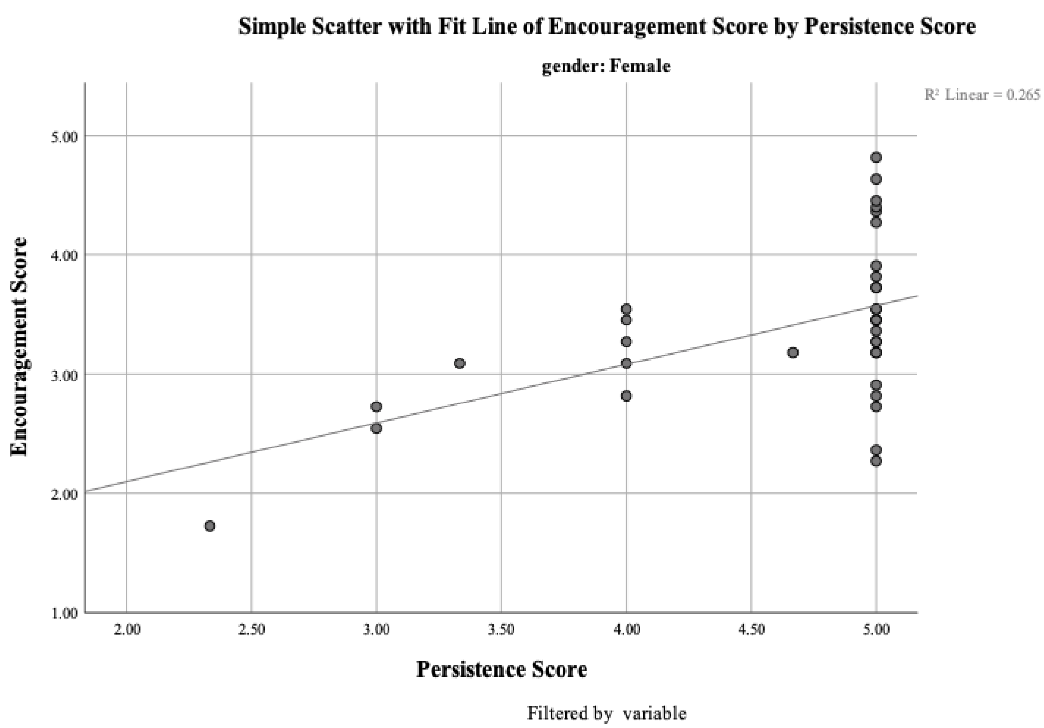
Comparison Results

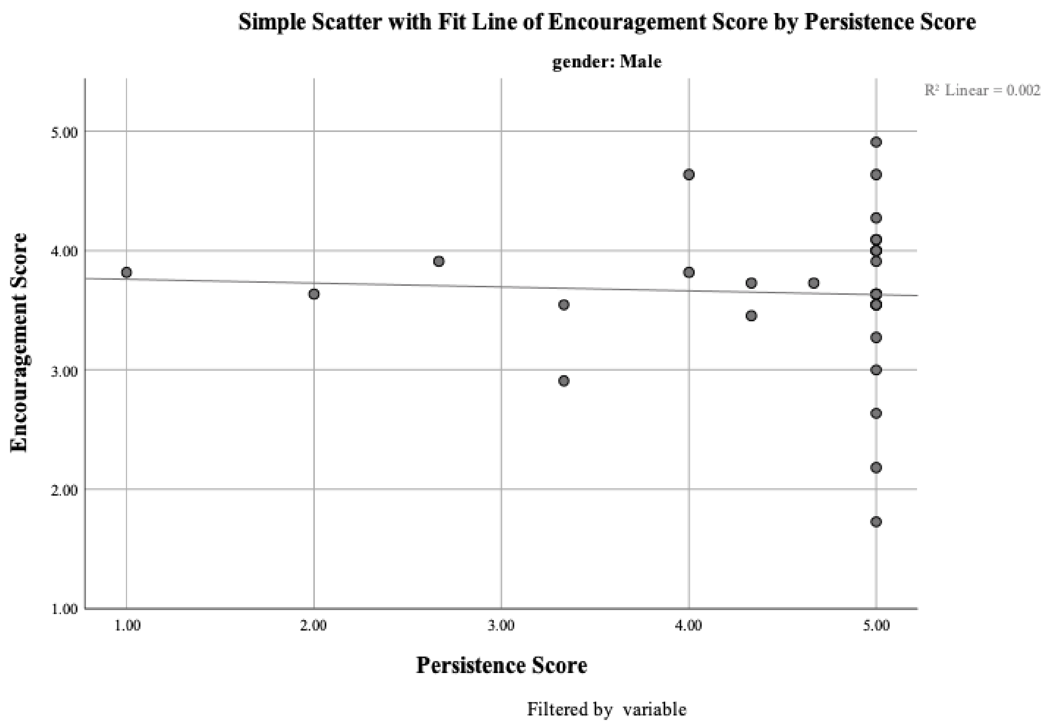
Before comparing the correlation of the encouragement and persistence scores, a scatterplot was created in IBM SPSS. Scatterplots can give the researcher an indication of whether variables are related in a linear or curvilinear fashion while also showing whether variables are positively or negatively related and by what relative strength (Pallant, 2016).

The following table shows scatterplots for encouragement score by persistence score for females and males.

Table 4.8

Scatterplots for Encouragement Score by Persistence Score





The encouragement and persistence scores for females were positively correlated, with results moving upward from the bottom left to top right, and reasonably strong with results generally clustered together. The scatterplot for male participants showed some difference with a slight negative correlation, as results start on the top left of the chart and drop to the right, and with weaker strength as results were scattered.

The relationship between encouragement, as measured by the composite encouragement score, and perceived persistence, as measured by the composite persistence score, was investigated using Pearson Product Correlation (r). Preliminary analyses were performed to ensure no violation of the assumptions of normality, and linearity. As a result, there was a strong, positive correlation between the two variables in female responses, r=.51 and n=35. There was a weak, negative correlation between the two variables in male responses, r= -.048, n= 32.

The following table shows the Pearson Product Correlation (r) between persistence scores and encouragement scores for male and female students.

Table 4.9

Pearson Product Correlation (r)

gender			Encouragement Score	Persistence Score
1.00 Female	Encouragement Score	Pearson Correlation	1	.515**
		Sig. (2-tailed)		.002
		N	35	35
	Persistence Score	Pearson Correlation	.515**	1
		Sig. (2-tailed)	.002	
		N	35	35
2.00 Male	Encouragement Score	Pearson Correlation	1	-.048
		Sig. (2-tailed)		.800
		N	32	30
	Persistence Score	Pearson Correlation	-.048	1
		Sig. (2-tailed)	.800	
		N	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

The results of the Pearson Product Correlation (r) showed a strong, positive correlation between female students being encouraged to use technology and to enter STEM in high school and college, and their rates of persistence in STEM programs. This would indicate that encouragement of female students does have an effect on their persistence in STEM programs.

Results for male participants show a weak, negative correlation between their encouragement to use technology and to enter STEM in high school and college, and their rates of persistence in STEM programs. The Sig. (2-tailed) score of .800 shows there may not be significance in this result which may be due to a small sample size. It is reasonable to conclude that a larger sample size would likely show a flat line, indicating no correlation, rather than a negative correlation. This would indicate that male encouragement, while higher than those reported by female participants, had less effect on whether they persisted in their STEM college program.

Results of Interviews

Interviews were designed to understand more deeply the lived experiences of female students in STEM college programs, the "critical points" during their education that may affect their persistence in these programs, and whether STEM and CTE in their secondary education schools had any effect on persistence on the college level. Question 9 on the survey asked respondents whether they would be willing to participate in a 60-minute in-depth interview. Three female students agreed, all third-semester STEM students, and all older than the dominant age group of STEM student participants. According to survey results, the vast majority of students reported their age as 18 to 24, while the three interviewees were older than this age range. Interviews were transcribed and pseudonyms were given to each participant. The pseudonyms for the three participants were Amy, Brenda, and Carly.

Amy was a 41-year-old, White, middle-class ambulance worker. A back injury forced her away from emergency response work and into a school for nursing. She had an upbringing that was supportive of technology growing up with her "father as a role model," and a "family computer at home." Her high school also incorporated technology and the internet, though there were no programs specifically termed "STEM" during her secondary education. She used a community service opportunity in high school as an entryway into emergency services.

Amy was self-determined to enter nursing, even after her advisor "pushed me away from STEM" because of a back injury. Persistence in the program has not been easy because of an “age disconnect” from other students in her cohort and a poor experience with one of her professors. She has found more female students in her STEM classes than males and sees the gender breakdown of students as a neutral factor in her persistence. More important to her were positive experiences with professors, peer support when available, and her own self-determination to enter a STEM field. She also valued that the STEM program focused on teamwork because STEM careers require working in a team to be successful.

Brenda was 40 years old, White, and middle class, studying Geology and Environmental Studies. Brenda had “natural curiosity about technology” and a computer at home while growing up. She reported that she felt “boys were encouraged to use technology” while girls were not. She used to watch males work with technology in order to learn for herself and “still feels the effects of not being pushed toward technology” when she was young. She feels as though she did “not receive adequate training in math” in high school because specialized classes in science de-emphasized math in favor of specialized computer skills. She eventually dropped out of high school “to have a family.” Brenda felt strongly that females “have to choose career or family,” and that there is no middle ground. Once her kids were older she decided it was a good time for her, and her family, to return to school and pursue a career in science.

In her current college program, Brenda has been encouraged by her professors. She reports more males in STEM classes overall and that the “male percentage increases with advanced class levels.” She found that females in lower-level STEM classes “prepare for female majors,” such as nursing and that, in general, females are “afraid of math” in higher level STEM courses. She also believes males are “pushed along to advanced classes.” She found her STEM program to be encouraging overall in various small ways. She believes that professor encouragement and the cohort as a support system were beneficial to keeping her in the program but that her self-determination was most key saying, “it is my time.”

Carly was the youngest participant interviewed at 29, White, and middle class with a major in Life Sciences. She credits her dad and siblings with introducing her to technology. She had a Technology Education computer class in high school but found the computer training “very basic.” She found that “males were expected to understand technology” but that females were not. She lost an interest in STEM in high school because her teachers were not “engaging.” Carly decided to make a career change after working in a non-STEM industry and felt the time was right to enter college.

Carly is self-motivated to be in college and in a STEM program. She reports being given “very little information about STEM” through the application and advising process and was “already taking STEM classes before meeting an advisor.” She also found her advisor did not have a STEM background and was not helpful overall when she had questions. She credits her professors and the subject matter for making her experience in STEM positive. She has found no cohort in the program as of her current semester and that gender breakdown in classes has been about even. She also reports no interaction with program staff besides her professors and advisor. She is motivated to stay in STEM by “real-world application” of what she learns. She also found her professors, who could be both encouraging or discouraging, depending on the experience, to be particularly influential to her feelings of persistence in the program though is self-determined to persist toward completion.

Prominent Themes

Interviews were transcribed and prominent themes among the three participants’ answers were categorized according to what most encouraged them or dissuaded them from completing their STEM college program. The most prominent themes from the interview include (1) having technology at home, (2) a lack of encouragement in high school, (3) unequal college structures (4) a STEM career focus, and (5) individual persistence.

Theme 1 – Having Technology at Home

All three interviewees had technology-rich households growing up and a father figure who was encouraging in technology-use. Amy indicated that “we would build our own family computer at home,” getting as detailed into the process as picking out the mother board from scrap items and choosing which programs to install. Her father was also instrumental in introducing her to technology and other skills that would be traditionally “male” saying “my father was very much into ‘you will be a productive member of society, whether you are male or female…and you will be able to be an independent person who can change a flat tire,’ that kind of thing.”

Brenda had a natural curiosity for technology growing up saying “people would throw things away and I’d pick it up off the street.” She even programmed an old apple computer: when she found a manual “I tried to figure out how to program it. I made a rocket shoot off the screen after four hours of typing in the codes.” Carly cited her family as introducing her to technology as “my siblings and I would just play a lot of computer games and Nintendo games and point and click stuff…and (we had) AOL (America Online) and dial-up and all that.” Her dad, in particular, was a large influence as “we built bird houses and corn hole games…we did all of the physical projects.”

Theme 2 – A Lack of Encouragement in High School

Amy went to a high school that was “big on technology…we had computer classes” but “there was no STEM that I knew of in 1995 when I graduated high school. It didn’t exist where I was." Brenda had a specialty program in her school called Computer Algebra. "We did everything on computers" but even after having the top test scores in her group "I never learned algebra…I took an Algebra class and was in shock, and then I couldn't do Chemistry, which meant I couldn't do Physics classes because I never had math."

Carly said that her high school had "one Technology Education class and one computer class." She went on to explain "the tech classes in high school were really basic…you just follow the steps of a project and you don't really learn how to do anything; you just do something." She also said that high school made her less likely to study STEM in college because "the teachers were not engaging and had no alternative methods for helping people understand outside of the textbook." Finally, she realized, "I don't care about this."

Theme 3 – Unequal College Structures

The three interviewees echoed lack of STEM-specific advisors as a hurdle to enrollment. Amy said that "I came in knowing what I wanted to do…and we looked at it and she (the advisor) actually encouraged me to do some other programs" because of a medical issue. She went on to say that "my heart is set in the medical field…and once I informed my advisor that that's what I was going to do, she got on board." Brenda said her advisor "wasn't enthusiastic" about her taking a STEM major. Carly did not even see an advisor "until I had a semester and summer done." The advisor was found to have no background in STEM which was unhelpful because "he has no background in science at all and he's basically just (telling me) 'keep up what you're doing' and that's about as much advice as I've gotten."

Amy had mixed feelings for her cohort saying "It's kind of hard for me because I am 41 years old. A lot of people on campus are 22. So, it's hard to relate" while also believing that "people in STEM get more encouragement from each other because we all understand the goals and we have to be team players." Brenda found her cohort to be positive overall saying 'it's just a good support system." Carly found no sense of cohort or community in her STEM program.

Professors were mentioned by all three students as particularly effective as class, program, and STEM-field supports. Amy said that her Anatomy and Physiology professor "is amazing... she has such a love of science and she's willing to explain things in different ways…which makes it really easy to want to continue in her class, but also continue for the next class." Overall, Brenda found that "the people that I have, professors, and everyone here (at the college) is much more encouraging than I've ever experienced anywhere ever before." Carly said that she has had "really good" professors who also encourage her by saying "I don't know what your plans are or what your life desires are but, based on your performance here, and how you're understanding things, you can do so many things…don't let life limit you."

Theme 4 – A STEM Career Focus

The interviewees revealed concerns that making it into STEM careers was still more challenging for females than males. Much of this was due to females needing to take care of the family while males were seen as more free to follow their careers. Amy told a story of a female student in her program who had to drop a course because of family issues saying, "I think, to this day, the daughter will take care of the ailing parents rather than the son." Brenda thought that males dropped out of the program because of boredom while "females drop out because they are overwhelmed…we put extra pressure on ourselves to do well."

Even with these added gender challenges to achieving a STEM career, responses were strong overall for all three participants on wanting to complete their program and enter STEM fields. Amy said that "nursing has a reputation for being very difficult but also an amazing profession." Brenda would like to go on to "Geology and Environmental Science, like water and hydrology…it's one big mess, and that should keep me happy." Carly stated that "science is so cool. It's the world. It's literally just studying how the world is and works." She feels that "to think that I could find a way to put that to a career would be awesome."

Theme 5 – Individual Persistence

Individual persistence also was a key factor to motivate program completion for all three students. Amy stated that "when I worked on the ambulance I really enjoyed helping the patients. And that's my motivation to get through the program." Brenda felt that for her it was "my happiness, it's what I want to do so…do it! I've waited. I've been patient. Now I have four kids, I've helped my family out, it's my turn. Get out of my way." Carly finds motivation to persist through completing classes saying:

> I want to learn the 400-level stuff but I have to go through the 100 and 200 to get there…if I just get through it, and if I actually learn it by passing a test, then I will be able to get to the things that are even more interesting and applicable to real-world situations.

Quantitative and Qualitative Review

Creswell & Creswell (2018) write that quantitative and qualitative data both have their own strengths and limitations but when used together can strengthen understanding of the research questions. The quantitative data in this study helped the researcher visualize overall trends for encouragement and persistence in the targeted STEM program as well as how those differences manifested by gender. Males showed stronger encouragement scores compared to females but that encouragement was less directly tied to their feelings of persistence in the program than those of females. Persistence scores were stronger for females overall though they reported weaker levels of encouragement compared to males in the program. The Pearson Produce Moment Correlation (r) output (see Table 4.9) confirmed that there was correlation between encouragement for females and feelings of STEM persistence but this finding could not be correlated with confidence for males.

Qualitive data were then used to provide depth, insight, and context into the data collected from the surveys (Creswell & Creswell, 2018). Interviews helped to clarify why encouragement for females was lower than for males as interviewees expressed negative feelings for specialized technical training in high school that may have come at the expense of core math and science skills. Subjects also detailed a lack of direction and expertise from college structures that may have led to feelings of less encouragement. Theoretical perspectives involving motivation and goal setting (Dweck & Leggett, 1988) were also confirmed by interviewees who discussed how their self-determination was built through role models using technology at home when they were growing up and by motivating faculty interactions in their STEM programs.

Summary

Survey results indicated that males received more encouragement in their family lives, high school, and college programs than females, though female participants showed stronger persistence scores, which indicate strength of intention to graduate and pursue a STEM career. Interviews gave a deeper look into the encouragement experienced by female students with five major themes showing consistency between participants: having technology at home, a lack of encouragement in high school, unequal college structure, a STEM career focus, and individual persistence. Individual persistence manifested itself most strongly by interview participants as a reason for wanting to complete their college programs and find a job in a STEM field. The following chapter will explore limitations of the study, the results’ connection to prior research, and recommendations for future research.

CHAPTER FIVE: Conclusions and Recommendations

This study aimed to understand what factors affect female student persistence in STEM college programs. Surveys were used to gather quantitative data on a number of factors that the literature revealed may affect persistence including societal attitudes around gender, the high school experience, self-efficacy, STEM and CTE background, experiences within the STEM college program itself, and career prospects in a STEM career field. Interviews were then conducted with three students to understand more deeply what many of these experiences may have entailed and how they may have specifically led to persistence in their STEM program.

Research Question 1

What keeps students, and in particular female students, persisting through successful completion of STEM college programs in a community college?

The encouragement scores for females was calculated as a 3.38 while males scored a 3.65, which is consistent with previous literature on the subject that males receive more encouragement to pursue technology both socially and professionally (Yang & Carroll, 2018). According to the survey, males scored highest for encouragement in the areas of professor encouragement, with 90% agreeing to the statement, and STEM career fields having higher paid jobs than non-STEM fields, with 81% agreeing to that statement.

For female students, scores were particularly high for encouragement in the areas of professors in the STEM program, with 85% agreeing to the statement, STEM careers offering higher paying jobs than non-STEM fields, with 62% agreeing, and use of technology by family and friends, with 62% agreeing, though all categories showed lower scores compared to how males responded to each question. Survey results for females was consistent with research by (Mbano & Nolan, 2017) who found role models as particularly effective in female retention and

(Beede et al., 2011) who advocate for making STEM fields more family-friendly and flexible as a way to encourage females into the field.

The persistence scores for females was calculated as a 4.60 while males scored a 4.45, which is a surprise based on previous literature that shows males have a stronger likelihood to persist in STEM majors (Maltese & Cooper, 2017). Scores of 4.60 and 4.45 are fairly high on a 5.0 scale, which the survey showed could be because of high encouragement scores for teachers at the college as well as strong feelings toward STEM careers. Students, especially female participants, may also have been too early into their school careers to have developed strong negative feelings for the program or to otherwise switch majors.

Interviews pointed to an answer more strongly focused on individual persistence. All the interview subjects spoke about their love of their field or major and of wanting to remain in STEM out of interest or passion. Simon et al. (2015) write that motivation and emotion can predict success for students in STEM programs, a finding originally championed by Dweck & Leggett (1988) who found that individuals' self-perception can have a major effect on goal setting and academic achievement.

Research Question 2

What are the lived experiences of female students in STEM community college programs?

Amy, Brenda, and Carly spoke about a lack of college structures, especially when looking for guidance or information about STEM. Advisors at the college were not found to have a STEM background or to be particularly encouraging in helping students register for STEM courses. Zinth (2014) makes a case for dual enrollment as a means to increase persistence in students by having them take college courses in low-stress situations and with a support system of college professors and high school teachers. Dual enrollment also offers students the opportunity to learn about college structures and services before they are enrolled as full-time.

Feelings for the effectiveness of a cohort among the interviewees was mixed. The idea of a cohort seemed to be strong for mutual support and comradery, but none of the interviewees reported any particular connection to their cohort or could detail a specific positive interaction. These feelings were likely due to the interviewee ages being outside of the majority 18 – 24 years old on campus. Literature on the effectiveness of cohorts in persistence such as (Carrino & Gerace, 2016) found that learning communities help to increase student social interactions, which can have a positive effect on academic outcomes.

Professors were found to be particularly influential to students. Their passion for the subject matter ignited an interest in students and their encouragement led to stronger feelings of self-determination. The reverse also held true with negative experiences with professors acting as barriers to persistence, though only one instance was given during interviews. Professors also acted as the primary face of the program, and to a lesser extent the college, making them particularly important to the encouragement and persistence of students. These findings are consistent with literature on the importance of the student and teacher relationship such as Herrmann et al. (2016) who write that females are more likely to leave STEM programs when they lack female role models such as professors.

Research Question 3

What are the "critical points" where female students tend to persist in STEM college programs?

This study found critical points for female students as indicators of STEM persistence to include early family life and use of technology, high school, the college program experience, and the overall perception of STEM careers. A major finding in this study was the importance of technology and support in home-life growing-up. There is little research available that can highlight why early technology use at home may be of particular importance to female students, which should be an area of further study. Interviewees in this study reported having technology access at home through family computers and video games. Amy and Carly had particularly supportive fathers while Brenda had a brother who allowed her to engage in technology with him. With this background all three were drawn to technology, science, and math programs in their high school. This may help to guide future research into family life as a reason for persistence with all three interview participants coming back to college a decade, or even two decades later, even after somewhat negative high school experiences in STEM.

Sass (2015) argued that high school is a particularly important time for females and minorities in STEM because if they lose confidence in their academic skills, they will not enroll into STEM programs at the college level. All of the interviewees reported having technical programs in their high school but found them lacking in remedial skills and not specific to STEM. Brenda was deeply turned off of a career in science because of a negative teacher in her high school. Basic skills in math and science were found to be minimal and further decreased interest in continuing on in either discipline after science with Brenda even saying, “girls are scared of math.” All three interviewees took off significant time before re-entering college as STEM majors.

STEM careers also serve as a major critical point for student persistence. All of the interviewees strongly voiced confidence in finishing their programs and working in a STEM-related field. This is somewhat counter to literature, which suggests that higher-income fields in STEM still show a significant gender gap in pay (Noonan, 2017), and that their lack flexible family-planning options in STEM fields such as engineering contribute to less female participation and higher female dropout (Blau & Winkler, 2017).

Research Question 4

How have the lived experiences in secondary education STEM and CTE programs influenced student persistence toward successful completion of STEM community college programs?

With research such as Means, Wang, Wei, Iwatani, & Peters (2018) highlighting the importance of high school STEM programs and (Kerby, 2015) advocating for secondary education teachers as mentors, it was surprising to find little correlation between the high school and college experiences in this study's interviews. Overall, there was a slightly negative finding in the themes of the interviewees for the high school experience. Two interviewees were enrolled in specialty high school technology programs, though none called STEM or CTE, which focused on computer skills but were felt by students to take away from learning critical core academic skills, especially in math. No student mentioned a specific STEM or CTE-to-college pipeline in their secondary education experience.

All three participants reported self-determination as a reason for coming back to college and enrolling in a STEM program, mentioning their high school as lacking in teaching necessary math and science skills. Amy, in particular, felt that she was deficient in algebra skills, preventing her from taking necessary science classes in college. Sublett & Plasman (2017) write that having students take STEM coursework in high school was predictive of their taking STEM courses in college, making this study's findings contrary to much of the research on the importance of high school to student persistence in STEM at the college level.

Limitations Found in the Study

While the survey pool had a wide reach within the STEM college, and was targeted toward second-year students, the strong initial survey responses did not translate into a large number of interview participants. Of the eight students who confirmed interviews by email only three showed for their time slot. While the three participants were forthright in their answers and generous with their time, three remained a small sample size. Perhaps more critical as a limitation for the study was the age of the interviewees: 29, 40, 41, somewhat older than the 67% of students on campus who are 24 years-old and under (“The Integrated Postsecondary Education Data System (NCES),” 2018). It should be noted that 64.7% of survey respondents reported to be 18 to 24-years old in the survey, none of whom agreed to participate in the interview.

The interviewees may have had a different secondary education experience ten to twenty years ago, before the development of modern STEM and CTE and the specialized recruitment of women into STEM college programs. They are also students returning to college after time away from school, potentially making them more likely to have traits of self-determination and persistence that they spoke about passionately and a reason why they agreed to participate in the in-person interview while their younger peers did not.

Recommendations to Further Research

This study affirmed much of what researchers such as Bandura (1999) wrote about self-efficacy and its role in decoding why females persist in STEM. Further research should continue to look into how self-efficacy is built, sustained, and translated into persistence in majors which tend to be male-dominated and which offer poor family-planning options for female workers.

The study also touched upon ideas championed by Dweck & Leggett (1988) into building behaviors that could lead students to mastery of a subject or to drop out. While high school training and encouragement was not found to encourage students to persist in STEM, use of technology in the family setting was found to be effective in encouraging students to pursue STEM fields. More research into family life and role models of female students would be useful to more clearly define this connection. The students interviewed had role models and access to technology outside of high school, which may play a large role in building self-efficacy.

College program structures should also be examined as all three interviewees had little connection to their advisor and all stated that their advisor had little experience in STEM. Outside of their individual professors students had difficulty finding expertise when STEM-specific questions or issues arose. While the relationship between the professor and the student within the classroom has been explored by researchers (Ausburn et al., 2009), the use of this relationship in an advisory role, as opposed to a purely academic role, could be further explored.

The age of the student interview participants in this study raises intriguing questions about the current traditional structure of college programs. With time away from school and the STEM field, all three students showed remarkable energy and determination to complete their programs. Could there be a useful model or program structure that caters to older students where they do not feel disconnected to the program because of their age in relation to the majority of other students? Amy was able to situate her professional life with time away from school; Brenda was able to marry and start a family before returning, and Carly regained a passion for science with her time away. This may signal that maturity could be a factor in student persistence.

It would also be useful to look at the structure of STEM careers. Brenda spoke eloquently about the decision she felt females need to make between starting a family and a career. She did not see a pathway that allowed both. This fits neatly with research by Smith et al. (2018) who found lower STEM enrollment and completion numbers for female students because of the perception of inflexible STEM careers. STEM fields could work to model their employment, pay, and benefit structures after fields such as education and nursing where there are strong numbers of female workers (Bureau, 2014). The work of making the STEM career environment more enticing to females may be particularly helpful in increasing positive perceptions of these fields and translate to stronger persistence in college programs.

Finally, while beyond the scope of this study, further research must include data on race and socioeconomic status. Besler et al. (2018) found disparities in STEM participation and completion across and within ethnic groups, leading to a cycle where minority students become less able to participate in STEM each generation. Research is already underway at the intersection of gender and ethnicity and their connection to program enrollment, completion, and job attainment (Bastedo et al., 2016).

Conclusion

This study sought to find reasons for female student persistence in a STEM college program. Prior research suggested a number of factors for female students to drop out of these programs including social views of females and technology, unequal technology exposure in high school, poor STEM recruitment in high school, lack of recruitment to STEM college programs, not enough female role models in these programs, and nonexistent family planning options within STEM career fields.

Use of technology in early family life was shown to have a major effect on persistence and could lead to STEM interest at the high school and college levels. Most encouraging, while theorists, most notably Albert Bandura and Carol Dweck, wrote about self-efficacy as critical to persistence, this study was able to show real-world examples of these ideas in practice. In spite of many of these barriers placed before female students, their self-determination allowed them to persist and gave them strong passionate feelings toward continuing toward graduation and careers in STEM fields.

Questions raised by this study include: what effect do race, first-generation status, and socioeconomic status have on persistence in STEM programs for female students? Are there specific college structures that can be built to help female students persist once on campus? And what recommendations can be provided to STEM fields to create a working environment which encourages female workers to apply and persist? Further research should also focus on specific ways home life and access to technology at an early age play a role in creating self-efficacy as well as if time away from school may increase program completion rates as students gain maturity.

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Appendix A

Instrument Methodology Chart

Research Questions	**Data**	**Statistical Method**	**Analysis**
1. What keeps students, and in particular female students, persisting through successful completion of STEM college programs in a community college?	Encouragement Survey questions: 6, 8 Persistence Survey question: 7	Correlational study between total encouragement score and three persistence outcomes. The independent variable is the encouragement score while the dependent variable is the persistence score.	An "Encouragement Score" will be obtained by totaling the scores in item 6 and dividing by the number of questions. The Encouragement Score will then be paired with the individual "Persistence Outcomes" in question 7. A Pearson Product Moment Correlational Coefficient (r) will be computed to determine the strength and direction of the relationship between the two variables
2. What are the lived experiences of female students in STEM community college programs?	Interview questions 8, 9, 10, 11, 12, 13, 14, 16, 17, 18	Qualitative review of themes	Interviews will be transcribed and coded to find whether there are common themes in experiences for students in STEM programs.

3. What are the “critical points” where female students tend to persist in STEM college programs?	Interview questions 1, 2, 3, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18	Qualitative review of themes	Interviews will be transcribed and coded to find whether there are common themes of “critical points” where students may decide to persist-in or drop-out of STEM programs.
4. How have the lived experiences in secondary education STEM and CTE programs influenced student persistence toward successful completion of STEM community college programs?	Interview questions 4, 5, 6, 7	Qualitative review of themes	Interviews will be transcribed and coded to find whether there are common themes of students persisting because of their experiences in CTE secondary education programs.

Appendix B

Survey Consent Form

I am currently engaged in a study of persistence in science, technology, engineering and mathematics (STEM) college programs. As a participant in this survey, you will be asked to answer a series of questions about your history using technology, areas of encouragement in STEM programs and your future plans in STEM.

You could be asked to recall potentially uncomfortable past history related to technology use or experiences in STEM programs. Your participation in this study is on a voluntary basis, you may skip any questions that you wish, and you may refuse to participate at any time without consequence or prejudice. I welcome questions about the experiment at any time. Gaining an understanding of both positive, and negative, experiences in STEM programs could be of benefit to the field of study. The survey is anonymous; it will not ask for any identifying information.

Any questions you have about the research can be directed to me, Yaniv Aronson, Doctoral Student in the College of Higher Education at Immaculata University, at yaronson@immaculata.edu, or 610-608-9844, or to my supervisor, Dr. Christine Cavanaugh at ccavanaugh@immaculata.edu.

Questions about your rights as a participant can be directed to the Immaculata University RERB Chair, Dr. Thomas F. O'Brien, at 610-647-4400, ext. 3210, or by email at tobrien@immaculata.edu, or to the Montgomery County Community College IRB Director, Dr. David Kowalski, at dkowalski@mc3.edu.

Signing your name below indicates that you have read and understand the contents of this consent form, that you agree to take part in this study and that you are at least 18 years of age. Signing this form will not waive any of your legal rights.

____ ________________
Participant's Signature Date

____ ________________
Researcher's Signature Date

Thank you,

Yaniv Aronson

Appendix C

Survey Questions Instrument

Student persistence in STEM college programs

1. Overview

I am currently engaged in a study of persistence in science, technology, engineering and mathematics (STEM) college programs. As a participant in this survey, you will be asked to answer a series of questions about your history using technology, areas of encouragement in STEM programs and your future plans in STEM.

The survey is anonymous; it will not ask for any identifying information. Your participation in this study is on a voluntary basis, you may skip any questions that you wish, and you may refuse to participate at any time without consequence or prejudice. I welcome questions about the experiment at any time. Any questions you have about the research can be directed to me, Yaniv Aronson, Doctoral Student in the College of Higher Education at Immaculata University, at yaronson@immaculata.edu, or 610-608-9844, or to my supervisor, Dr. Christine Cavanaugh at ccavanaugh@immaculata.edu.

Any questions about your rights as a research subject may be directed to the Immaculata RERB Chair, Dr. Thomas F. O'Brien, at 610-647-4400, ext. 3210, by email at tobrien@immaculata.edu or Room 130 Loyola Hall.

If you select "no," do not proceed beyond this point. Please return your survey when the others are collected.

* 1. Informed Consent

- ◯ Yes, I would like to complete this survey
- ◯ No, I do not wish to complete this survey

Student persistence in STEM college programs

2. Survey

Dissertation Research: This research seeks to understand what factors affect student persistence in higher education Science, Technology, Engineering and Mathematics (STEM) programming.

* 2. In what semester at MCCC are you currently enrolled?

- ◯ First Semester
- ◯ Second Semester
- ◯ Third Semester
- ◯ Fourth Semester
- ◯ Fifth Semester
- ◯ Other (please specify)

3. How would you best describe your major?

- ◯ Science
- ◯ Technology
- ◯ Engineering
- ◯ Math
- ◯ Communications
- ◯ Other (please specify)

* 4. What is your gender identification?

- ◯ Male
- ◯ Female
- ◯ Other

5. What is your age?

6. The following statements are designed to understand what factors help encourage you to persist in STEM classes and programs. Please indicate your level of agreement or disagreement with each of these statements.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Growing up I was encouraged to use technology by my family and friends.	○	○	○	○	○
I was encouraged to use technology in high school.	○	○	○	○	○
My high school prepared me for college.	○	○	○	○	○
My high school prepared me for a major in STEM.	○	○	○	○	○
I was encouraged to take STEM classes in middle and high school.	○	○	○	○	○
I was encouraged by my high school advisor to take STEM classes in college.	○	○	○	○	○
I was encouraged by my college advisor to take STEM classes at MCCC.	○	○	○	○	○
My STEM college professors encourage me to succeed in class.	○	○	○	○	○
I have found STEM college administrators helpful and supportive (Dean, Department Head, etc.).	○	○	○	○	○
My STEM class cohort provides me with support when I struggle.	○	○	○	○	○
STEM careers pay better than many non-STEM fields.	○	○	○	○	○

7. The following statements are designed to understand your future plans in STEM programs. Please indicate your level of agreement or disagreement with each of these statements.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I plan to complete my STEM-major college program.	○	○	○	○	○
I plan to graduate with a STEM degree.	○	○	○	○	○
I plan to enter a STEM career field.	○	○	○	○	○

8. What factor do you think most encourages you to persist toward degree completion in a STEM field?

Thank you for taking the time to provide your input on student persistence in STEM college programs. If you would like to be considered for an interview please proceed to survey question 9.

Student persistence in STEM college programs

3. Interview Question

9. There will be a small sampling of participants chosen to have an in-depth interview to gain further information about persistence in STEM college programs. If you are are interested in participating in a confidential follow-up interview regarding your experiences and history with technology, and within your STEM college program, please provide your name, email and phone number below. The interview will last 60 minutes.

Name

Email

Phone Number

Thank you for taking the time to answer questions about your experiences in STEM programs. If you have any questions please contact the researcher, Yaniv Aronson, by email at yaronson@immaculata.edu or by phone at 610-608-9844.

Appendix D

Interview Consent Form

I am currently engaged in a study of student persistence in science, technology, engineering and mathematics (STEM) college programs. As a participant in this survey, you will be asked to answer a series of questions about your history using technology, areas of encouragement in STEM programs and your future plans in STEM.

I anticipate that this interview will last approximately 60 minutes and take place in a mutually agreed upon location. You could be asked to recall potentially uncomfortable past history related to technology use or experiences in STEM programs. Your participation in this study is on a voluntary basis, you may skip any questions that you wish, and you may refuse to participate at any time without consequence or prejudice. I welcome questions about the experiment at any time. Gaining an understanding of both positive, and negative, experiences in STEM programs could be of benefit to the field of study.

Your identity will remain confidential, and your answers will be shared under a pseudonym. With your permission, I will record this interview, so that I can accurately analyze your responses later. This audio recording will be destroyed within two weeks of recording.

Questions about your rights as a participant can be directed to the Immaculata University RERB Chair, Dr. Thomas F. O'Brien, at 610-647-4400, ext. 3210, or by email at tobrien@immaculata.edu, or to the Montgomery County Community College IRB Director, Dr. David Kowalski, at dkowalski@mc3.edu.

Signing your name below indicates that you have read and understand the contents of this consent form, that you agree to take part in this study and that you are at least 18 years of age. Signing this form will not waive any of your legal rights.

____ ____________________

Participant's Signature Date

____ ____________________

Researcher's Signature Date

Thank you,

Yaniv Aronson

Appendix E

Interview Questions Instrument

Student Interview Guide

Thank you for taking the time to participate in this interview today. I am conducting this interview to gain an understanding into your experiences in STEM programs at this college and about your persistence (decision to complete or stay) in the program. I anticipate that this interview will last approximately 60 minutes. If, at any point, you do not feel comfortable please tell me. This interview is completely voluntary, and you may choose to skip any questions or end the interview at any time without consequence. Your identity will remain confidential, and your answers will be shared under a pseudonym. With your permission, I will record this interview, so that I can accurately analyze your responses later. This videotape footage will be destroyed within two weeks of recording. Do you feel comfortable proceeding? Do you have any questions before we begin?

1. When growing up, who introduced you to technology (video games, smart phone apps, computer and internet use)?
    a. How did they introduce you to technology?

2. In what ways did you use technology outside of school growing up?

3. Can you describe any differences you experienced between how males and females were introduced to technology?

4. What types of opportunities were you given to use technology in high school?

5. Were you a part of a Career and Technical Education (CTE) or STEM (science, technology, engineering, math) program in high school?

    a. If so, can you describe the program and specific area of study?

b. In what ways did this experience effect your decision to study STEM in college?

6. How did you find out about STEM programs in high school?

7. Can you recall any specific experiences in high school that made you want to study in STEM programs in college?

8. Once on a college campus, did any faculty or staff give you information about STEM programs?

a. If so, how did they encourage you to pursue these programs?

9. How did your college academic advisors describe STEM programs at MCCC to you?

10. In what ways have your STEM professors helped you in your classes, program or major?

11. Can you describe your sense of belonging in your STEM program (are you comfortable in your classes, do you feel you have supportive peers, teachers and administration)?

12. What is your perception of the male to female breakdown (or gender differences) in your STEM classes.

a. What were the positive, negative or neutral factors you noticed as a student in the program?

13. What was your experience with campus staff or faculty in the STEM programs?

a. Can you describe further any particularly positive or negative experiences with campus staff or faculty in STEM programs?

14. Do you generally see the same students in your STEM program (do you have a cohort)?

a. If so, can you describe your interactions with your cohort?

b. What is your perspective on the value of the cohort in these programs?

15. What do you know about STEM careers?

a. Does a career in STEM motivate you to complete your college program or stay in the major?

16. What is your perspective on males or females that switch out of your STEM program? In your opinion, what might be the reason for this?

17. What are your future plans for your STEM major after this semester?

a. What would you say, overall, has most encouraged you to stay (persist) in the program?

OR

b. What would you say, overall, pushed you to drop out of STEM?

18. Is there any other information about your experiences in STEM college programs at MCCC that you would like to share?

19. For demographic purposes:

a. What is your specific program of study at MCCC?

b. How do you identify in terms of gender?

c. What is your current semester at MCCC?

d. How old are you?

Thank you for taking the time to interview with me today about your experiences with technology and STEM programs.

Appendix F

Interview Transcriptions

Student Interview Guide (Amy)

Thank you for taking the time to participate in this interview today. I am conducting this interview to gain an understanding into your experiences in STEM programs at this college and about your persistence (decision to complete or stay) in the program. I anticipate that this interview will last approximately 60 minutes. If, at any point, you do not feel comfortable please tell me. This interview is completely voluntary, and you may choose to skip any questions or end the interview at any time without consequence. Your identity will remain confidential, and your answers will be shared under a pseudonym. With your permission, I will record this interview, so that I can accurately analyze your responses later. This videotape footage will be destroyed within two weeks of recording. Do you feel comfortable proceeding? Do you have any questions before we begin?

1. When growing up, who introduced you to technology (video games, smart phone apps, computer and internet use)?

Umm mostly, my father (1:14). But we got some of it in school. In high school.

   a. How did they introduce you to technology?

My father builds computers.

Interviewer: Did he let you be a part of that process?

Yes.

Interviewer: And what were you physically doing?

Well, he worked for GE. So, he was doing their computer systems. We're going back to the 80's now (laughs). Before smartphones. Before all the technology we have now. When there

was this whole big tower, and everything was stationary at a desk. That kind of Thing. Um, so we would build our own family computer at home. So, we would pick out the mother board. We would pick out the programs. He would show me how to load on those. And my brother and I would play the old video games on the computer. You know, Space Invaders, and those relics. Um, and the type of game where it would tell you something happened, and you would type in what you wanted it to do next.

Interviewer: Like Oregon Trail?

Yes. And then you go through it that way.

2. In what ways did you use technology outside of school growing up?

3. Can you describe any differences you experienced between how males and females were introduced to technology?

Absolutely. Males are more pushed towards Engineering, umm, being an electrician, that kind of thing. Where women were more pushed towards being a teacher or nursing or there were still gender roles and jobs in the early 80's and 90s (laughs), which is when I was in high school.

Interviewer: Did you personally feel that push?

No. My father was big on "I don't care if you are a male or a female, knowledge never hurts. Knowledge is power." So, for example, before I was allowed to drive I had to mow the lawn for the summer and a half before I turned 16. I had to learn how to change a tire, put my fluids in, before I was allowed to get my license. So, my father was very much into "you will be a productive member of society, whether you are male or female," because I had a brother, "and you will be able to be an independent person who can change a flat tire and that kind of thing…(trails off).

4. What types of opportunities were you given to use technology in high school?

I went to Merion Mercy Academy, so an all-girl high school. And it's actually a college-prep school for girls (4:24). Umm, they were big on technology. We had computer classes, and, for the time, I graduated in 95, so there weren't phones and all that other stuff yet. But, the world wide web had come out, so we had to use the world wide web to write a paper. You know, we still had a card catalogue in the library umm, which was put on the computer, so you had to know how to go through the computer in order to find the book you were looking for, to find where it was on the shelf. So, they pushed a lot of technology, they tried to push a lot of science also but back in the 90's there was only so much you could push.

5. Were you a part of a Career and Technical Education (CTE) or STEM (science, technology, engineering, math) program in high school?

No.

a. If so, can you describe the program and specific area of study?

b. In what ways did this experience effect your decision to study STEM in college?

6. How did you find out about STEM programs in high school?

There was no STEM in 95 when I graduated high school. It didn't exist.

7. Can you recall any specific experiences in high school that made you want to study in STEM programs in college?

Umm, I loved my Bio teacher in high school. She was absolutely amazing. Umm, she I think was really on the cutting edge. She was big on critical thinking and, you know, "why do you think the frog's leg kicks when you put salt on it?" Like think it through. So, her encouragement, like, brought into a lot of my desire for science. And we did, Merion has a

big think about community service, so I started volunteering on an ambulance. And I did that for fifteen years, until I injured my back. And now I want to go…I've been working at desk (whispers: I hate a desk). So, I'm now going back for my Nursing and, I think, if, my high school teacher hadn't provided those critical thinking skills it wouldn't have sparked an interest for me to go back.

8. Once on a college campus, did any faculty or staff give you information about STEM programs?

Umm, I came in knowing I wanted to do Nursing and my advisor said "OK." And we looked at it and she actually encouraged me to do some other programs because of the injury to my back from EMS. She says she doesn't believe I will be able to do the lifting for the Nursing. So, she tried to re-direct me into other areas. But my heart is set in the medical field so I'm working with my doctors to strengthen my back. Physical therapy and that kind of thing so I can do the STEM program. And once I informed my advisor that that's what I was going to do, she got on board. I was really big on, let's see what credits you have already done, since I already have a bachelor's that will fulfill the requirements here.

a. If so, how did they encourage you to pursue these programs?

9. How did your college academic advisors describe STEM programs at MCCC to you?

10. In what ways have your STEM professors helped you in your classes, program or major?

Umm, right I'm taking Anatomy and Physiology. And my professor is amazing. She is amazing. She has such a love of Science and she's willing to explain things in different ways. So, if you don't understand the contraction of a muscle she comes up with another

way to mirror life with it. And you can understand it, which makes it really easy to want to continue, in her class, but also continue for the next class.

11. Can you describe your sense of belonging in your STEM program (are you comfortable in your classes, do you feel you have supportive peers, teachers and administration)?

Umm, for the most part. It's kind of hard for me because I am 41 years old. A lot of the people on campus are 22. So, it's hard to relate. It's hard for us to relate to each other. 22 and 40 have different life experiences (laughs). It's not anything that the university is doing wrong or anything like that. It's that I look at life a little differently.

12. What is your perception of the male to female breakdown (or gender differences) in your STEM classes.

I believe there's more females in my STEM classes than males.

a. What were the positive, negative or neutral factors you noticed as a student in the program?

I see it as neutral. You know, I see the people in my classes, whether they are male or female, have a passion for what they're learning. They're learning science. I have no desire to build a house and hammer a nail into a piece of wood. No. If people are following their desires, whether they're male or female, that to me is more important. And we're all on different journeys.

13. What was your experience with campus staff or faculty in the STEM programs?

a. Can you describe further any particularly positive or negative experiences with campus staff or faculty in STEM programs?

I had a professor who, umm, taught, not here, but at another university. And many times, stated that his students at another university were more important, which really

affected how he laid the atmosphere in the class. So that was a really hard class to finish because I didn't feel like he gave the appropriate attention as students that we deserved. But my Physiology professor now, I would tell anyone to take her in a heartbeat. She makes the class enjoyable. I emailed her on a Thursday, she got back to me on a Friday going "here's how you solve that." So, she's really supportive of her students.

14. Do you generally see the same students in your STEM program (do you have a cohort)?

Yup. Many are in my group together.

Interviewer: Do you find them to be helpful or hurtful?

I see both. I can see it helpful to have that peer to peer support, answering questions, that sort of thing. I can also see it hurtful as I'm not in Micro with this group of students, I'm only in A and P, and I'm older than they are so I don't really fit in with them because we don't have three classes together. I can see them getting what they need out of each other, but I can also see it out of an outsider's point of view.

a. If so, can you describe your interactions with your cohort?

b. What is your perspective on the value of the cohort in these programs?

15. What do you know about STEM careers?

Interviewer: So, you want to go into Nursing. How much do you know about Nursing?

A lot! (laughs).

a. Does a career in STEM motivate you to complete your college program or stay in the major?

When I worked on the ambulance I really enjoyed helping the patients. And that's my motivation to get through the program. I want to help people. Pretty much it's their darkest time of their life. You know, if you're in the hospital for anything, whether it's

giving birth to a baby or something else, being able to help and make someone's day a little bit better, and just being able to say "this is who I am." Nursing has a reputation for being very difficult but also an amazing profession. And I want to be counted among them.

16. What is your perspective on males or females that switch out of your STEM program? In your opinion, what might be the reason for this?

Some have dropped because of extenuating circumstances. Some got ill and dropped to take care of that family member. Some have dropped because what was required of the course was too much and they weren't maintaining the grade necessary to move on. I've seen both reasons for people dropping.

Interviewer: Did you detect any gender-related reasons for dropping?

The person who dropped because of family was a female. So, I think more to this day the daughter will take care of the ailing parents rather than the son. So, I can see that being a gender issue. But that's more society.

17. What are your future plans for your STEM major after this semester?

a. What would you say, overall, has most encouraged you to stay (persist) in the program?

Mostly the professors and the people in the cohort. There's a lot of "yeah you screwed up that test…so you're not good with nerves." Everyone is not good with everything. The encouragement you'll get on the next test. I think the people that go into STEM support each other more so than someone who's in Journalism or English. Because in STEM, if you know the job it's really a team-based job at the end of your STEM whatever it is. Whereas an editor is not a team. An editor just edits the book. I think a lot of people in the cohorts understand, we need to work together now but we also need to work together on a floor (in

nursing). People in STEM get more encouragement from each other because we all understand the goals is we all have to be team players.

OR

b. What would you say, overall, pushed you to drop out of STEM?

18. Is there any other information about your experiences in STEM college programs at MCCC that you would like to share?

19. For demographic purposes:

a. What is your specific program of study at MCCC?

Nursing.

b. How do you identify in terms of gender?

Female.

c. What is your current semester at MCCC?

This is my third semester.

d. How old are you?

I am 41.

Thank you for taking the time to interview with me today about your experiences with technology and STEM programs.

Student Interview Guide (Brenda)

Thank you for taking the time to participate in this interview today. I am conducting this interview to gain an understanding into your experiences in STEM programs at the Montgomery County Community College and about your persistence (decision to complete or stay) in the program. I anticipate that this interview will last approximately 60 minutes. If, at any point, you do not feel comfortable please tell me. This interview is completely voluntary, and you may choose to skip any questions or end the interview at any time without consequence. Your identity will remain confidential, and your answers will be shared under a pseudonym. With your permission, I will record this interview, so that I can accurately analyze your responses later. This videotape footage will be destroyed within two weeks of recording. Do you feel comfortable proceeding? Do you have any questions before we begin?

1. When growing up, who introduced you to technology (video games, smart phone apps, computer and internet use)?

Umm…I did. Umm, I just liked taking things apart. People would throw things away and I'd pick it up off the street and that was it. Then, um, I found a high school was getting rid of their old Apple Tandy [1000] so I begged my mom and my grandmother to grab them for me. Because they were just throwing them out. And I would just take them apart. And I found a manual and I tried to figure out how to program it. I made a rocket shoot of the screen after four hours of typing in the codes. So, it was me being curious and liking to take things apart.

   a. How did they introduce you to technology?

2. In what ways did you use technology outside of school growing up?

Yeah. Umm…oh just everything. Boys were allowed to play videogames. Girls weren't. Umm, when it came to mechanics and learning how to repair things boys were encouraged. I was begging people to show me how to do things. Because like, um, I wanted to know how a car worked. In order to learn how a car worked I would watch someone else do it. And when I got older I dated guys who thought could fix cars and that's how I learned (laughs). And I wasn't encouraged at all. Because when I was little I was told pretty much, "these are the Math classes you're going to take so you can learn how to balance a check book for your husband, if he allows you to." So, that's…that's still in here (points to head). (2:47)

3. Can you describe any differences you experienced between how males and females were introduced to technology?

Umm, yes and no. It was, my high school was split. They were really pushing for their blue ribbons and I was part of an experimental group called Computer Algebra. So, we did everything on the computers. I was in the first test group, but I never learned algebra and, until then, I had never learned algebra before. So, I was doing all this graphing and stuff on the computers and it was a lot of fun. But then I took an Algebra class and I was in shock and then I couldn't do Chemistry, which meant I couldn't do Physics class because I never had math.

4. What types of opportunities were you given to use technology in high school?

5. Were you a part of a Career and Technical Education (CTE) or STEM (science, technology, engineering, math) program in high school?

No, it was just your normal like "this is your Physical Science class and next in your rotation is Biology." We had extra classes like Environmental Science and Kinesiology that

I took. Like I maxed out on my science requirements by the end of 10th grade because we had intensive scheduling so I could take two sciences a year. I was asked to leave Chemistry because I could not do the math and they didn't want my grades looking bad. There wasn't a lot of (pause). I don't know I always thought it was weird that they required four years of English, but it wasn't six requirements of sciences. Or five requirements of Math. Everybody knows how to write, to a point, you can find an editor (laughs).

a. If so, can you describe the program and specific area of study?

b. In what ways did this experience effect your decision to study STEM in college?

Umm…I think it affected my ability. Because I'm now, 20 years later, starting college. I dropped out of high school and had a family, got to experiment with different types of agriculture and things like that. Little things I tried to teach myself along the way. But, a lot of my early experiences were being told "no" or that "you're stupid," you know those sorts of things, they stick with you.

Interviewer: Is the environment different now?

In some places. In younger, more adaptive places. Umm, cause I have a lot of friends who have their PHD's or getting their PHDs. And a lot of us talk and those of us who chose to step back, and have our kids, before a career. We have children. Those of us who chose to have children during our career lost their jobs. And the people who kept pushing for their education now have nobody. No mates. They have no children. It depends on how willing the environment is to encourage everyone equally.

6. How did you find out about STEM programs in high school?

7. Can you recall any specific experiences in high school that made you want to study in STEM programs in college?

8. Once on a college campus, did any faculty or staff give you information about STEM programs?

a. If so, how did they encourage you to pursue these programs?

9. How did your college academic advisors describe STEM programs at MCCC to you?

(6:33) I knew what I wanted. Taking things apart. Finding the source of issues. (laughs).

Interviewer: Did he (your advisor) try to dissuade?

Hmm…he wasn't enthusiastic. But, he's no longer here (laughs). The people that I have, other, professors, and everyone here is much more encouraging than I've ever experienced anywhere. Ever before.

10. In what ways have your STEM professors helped you in your classes, program or major?

Umm, my Math professors, they've all said the same thing, that (long pause) sort of that I'm getting in my own head and that's why I can't learn. Not that I can't learn, that I can't get the results that I want because I still struggle with math. I'm just getting in my own head.

11. Can you describe your sense of belonging in your STEM program (are you comfortable in your classes, do you feel you have supportive peers, teachers and administration)?

Yes, and I've had a lot of them trying to encourage me to look beyond my bachelors. "Get your master's and come back and teach or something." I don't know. There's been a lot more, just what I've seen with me and the other students, regardless of gender. "Just keep going. You'd be really good in research; you'd be really good in this." And just really

taking people's personalities and saying this is what you'll have to do in the real world. Push more here. It's been really…it's been different.

12. What is your perception of the male to female breakdown (or gender differences) in your STEM classes.

There's definitely more males. There's more males the further you go along. Like I had a pre-Calculus class last year where there were only three females in the entire class. I have another friend whose a Math major and she is the only female in any of her classes. I'm here for Environmental Science, and while I'm here some of those classes that are pre-requisites, like a Climate class, is pretty well split. There's other ones, like the lower level Biology classes, like the 121 and 122's are more female. But the 150's classes are more male because they're the one pushing to go for more science-level education. So, the lower level (students) are just like "I just need to get through."

a. What were the positive, negative or neutral factors you noticed as a student in the program?

Well it shows there are more males being pushed and going up to the higher-level STEMs than are the lower levels. Because the lower levels, where you have the higher accumulation of males to females, they're the ones that are going for the Dental Hygienist and the Nursing or Teaching. But all the ones up here (higher level classes) are going into Biotech, computers and Physics and everything else. That's how the class is split up. And a lot of the females, like myself, are afraid of the Math. Like there's a fear of math. They panic when they see letters and numbers together on the same place (laughs).

13. What was your experience with campus staff or faculty in the STEM programs?

a. Can you describe further any particularly positive or negative experiences with campus staff or faculty in STEM programs?

Nothing specifically. It's just an everyday encourage us to think, think outside of, like, what the paper says. Or critical thinking, the higher up in the classes you go.

14. Do you generally see the same students in your STEM program (do you have a cohort)?

Sometimes. It depends on who graduates when. Who drops out?

Interviewer: When you do find a cohort, is it a positive or negative for you?

Umm positive. It's just a good support system.

a. If so, can you describe your interactions with your cohort?

b. What is your perspective on the value of the cohort in these programs?

15. What do you know about STEM careers?

I would like to go on to Geology and Environmental Science, like water and hydrology. And that's the direction I want to go because it's one big mess, and that should keep me happy (laughs).

a. Does a career in STEM motivate you to complete your college program or stay in the major?

Umm..it's my happiness, it's what I want to do so…do it! I've waited. I've been patient. Now I have four kids, I've helped my family out, It's my turn. Get out of my way.

16. What is your perspective on males or females that switch out of your STEM program? In your opinion, what might be the reason for this?

I think males drop out because they get bored and are like "whatever, I'd rather play." But for females they drop out because they are overwhelmed. And that's like anything from Nursing through the computer programs or Physics and things like that. It's

overwhelming, there's a struggle, we put extra pressure on ourselves to do well. I think as a collective we all work really hard to get those A's and get those B's so that we know that we are doing well. And then we look around and we're like "you've happy with a C? How can you be happy with a C?" And that's, at least within my groups of people, over the past three years that's something we've chuckled about.

17. What are your future plans for your STEM major after this semester?

Well I'm still here for another year. I have a new math class this summer. And then I just have three more classes for my pre-requisite. Then I'm taking an additional Calculus 1 cause I'd rather take that here instead of a mass of 200 or 300 people. Yeah I want handholding that what I want (laughs). Just to help me through the math.

a. What would you say, overall, has most encouraged you to stay (persist) in the program?

Me. It's just what I want. It's what I've been waiting for.

OR

b. What would you say, overall, pushed you to drop out of STEM?

18. Is there any other information about your experiences in STEM college programs at MCCC that you would like to share?

I like it. It's great. It's encouraging. Everyone's very encouraging and there's a lot of (pause) people, whether professors, or other students, the tutors, just always really willing to help. I don't think I would be able to get as far without those resources (pause) just, with the math.

19. For demographic purposes:

a. What is your specific program of study at MCCC?

Umm, I think I fall under the Geology department. I'm here for Environmental Studies for now, getting my pre-requisites.

b. How do you identify in terms of gender?

Female.

c. What is your current semester at MCCC?

I've been here for a while. I go part-time, full-time, part-time, full-time because of my kids, juggling. So, this is my third.

d. How old are you?

I'm 40.

Thank you for taking the time to interview with me today about your experiences with technology and STEM programs.

Student Interview Guide (Carly)

Thank you for taking the time to participate in this interview today. I am conducting this interview to gain an understanding into your experiences in STEM programs at the Montgomery County Community College and about your persistence (decision to complete or stay) in the program. I anticipate that this interview will last approximately 60 minutes. If, at any point, you do not feel comfortable please tell me. This interview is completely voluntary, and you may choose to skip any questions or end the interview at any time without consequence. Your identity will remain confidential, and your answers will be shared under a pseudonym. With your permission, I will record this interview, so that I can accurately analyze your responses later. This videotape footage will be destroyed within two weeks of recording. Do you feel comfortable proceeding? Do you have any questions before we begin?

1. When growing up, who introduced you to technology (video games, smart phone apps, computer and internet use)? **Oh man, I guess my family. My dad definitely way more technologically savvy than my mom. My siblings and I would just play a lot of computer games and Nintendo games and point and click stuff. But also, a lot of nerdy games, like, like, I can't think of the name of them, but it was a robot in outer space, and you had to go on different missions and stuff. And like typing games. Games to learn stuff! Um, and AOL and dial-up and all that. And then, now it's just all so much simpler (smile).**
    a. How did they introduce you to technology?

2. In what ways did you use technology outside of school growing up?

3. Can you describe any differences you experienced between how males and females were introduced to technology? **Um, (long pause). I mean males, I feel like, always are expected to**

understand it better. Like, be the guy whose dealing with the VCR in the house and to be the one to fix something when it breaks. Whether it's like computer technology or just kitchen tech or something around the house like hammer and nail. Like, it's a male-dominated thing.

Researcher: Did you see that on a personal level when you were growing up? **So, sort-of in my parents but like I was always the one building stuff with my dad. I have a sister and a brother. My sister was not interested. My brother was like, I don't even know his level of interest. He was on a whole other plant. So, my dad and I did all of these projects together. We went and built bird houses and like corn hole games, and, and…my dad and my brother did all of the computer games together, but we did all of the physical projects. So, yeah, it was kind of flipped a little.**

4. What types of opportunities were you given to use technology in high school?

So, we had one Tech Ed class and one, um, computer class. I don't remember what the computer class was called but it was something beyond just "computers." (as in a basic computer class). Um, in middle school we had typing class to learn how to like to use a keyboard properly. And then the tech classes in high school were really (pause) uh, basic, and sort of you just follow the steps of a project and you don't really learn how to do anything, you just do something. Um, so like we used an etching machine to create a design and have it etched into a piece of glass but was it. Like we just drew a picture, put it on the computer and pressed a button. Um, so there wasn't a ton.

5. Were you a part of a Career and Technical Education (CTE) or STEM (science, technology, engineering, math) program in high school?

Just a couple classes, regular, generic classes.

a. If so, can you describe the program and specific area of study?

b. In what ways did this experience effect your decision to study STEM in college?

6. How did you find out about STEM programs in high school?

7. Can you recall any specific experiences in high school that made you want to study in STEM programs in college?

No. It was the opposite actually. Um, I'm ten years out of high school. I just started going back to school, now, for Science. I was always interested in it, through middle school. And when I got to high school (breath) I didn't love school so much, more for personal reasons. The teachers were not engaging and had no sort of like alternative methods for helping people understand outside of "this is the textbook, this is how this works, now you practice doing it." And, so it really like, not motivating. If it didn't make sense immediately, I was like "alright, I don't care about this." Uh (pause) and then a year ago, or no, a couple years ago, a while ago now, a few years ago, I started exercising for my own, like, mental and physical health. And realized, after a while of that, like I could probably put this same willpower that I'm using here to school. So, I signed up for a few summer classes in summer of 2018, and did all of the things I was supposed to do (slight laugh), did all of my homework and showed up, whatever, and it went very well. And I remembered how much I love Science. And so, then I signed up for more, and more, and more, and like just every semester I'm taking. I took Bio, and then I took Chemistry, and now I'm taking Anatomy and all the maths and Physics, all of that and it's amazing and I can't even decide what I want to do with it because they're all so cool and interesting. (5:59)

8. Once on a college campus, did any faculty or staff give you information about STEM programs?

No.

Researcher: So, you just wanted to do it?

I just…I think Science is so cool. It's the world. It's literally just studying how the world is and works. And that's it, like, you can give it more details but that's all it is.

a. If so, how did they encourage you to pursue these programs?

9. How did your college academic advisors describe STEM programs at MCCC to you?

So, I didn't actually see an advisor until I had, uh, a semester and a summer done. And completed it really well. Straight A's, 4.00, whatever. So, my advisory wasn't really…my advisor was a Theater guy. He's a STEM advisor but he's a Theater guy. So, he has no background in Science at all and he's basically just been like "keep up what you're doing." And that's about as much advice as I've gotten here.

10. In what ways have your STEM professors helped you in your classes, program or major?

Uh, so the professors...I've had really good professors. I've sort of lucked into some and looked up on RateMyProfessors (website) to find other ones. And, one teacher in particular, my Math teacher, who teaches very basic Math classes only, Math 100 and two Pre-Calculous classes. And that's the only levels of Math he teaches here. He teaches also at other places. Um, but has been, by far the most encouraging of making sure to pull me aside and say "listen, I don't know what your plans are or what your life desires are, but based on your performance here, and how you're understanding things, you can do so many things. And don't let the possibility, like don't let life limit you." Um, and he said, like if I don't (pause) I don't know how you can describe it. It was like really nice, and amazing to hear, from a teacher who clearly knows what he's talking about. And makes a point often to talk about what math actually means in the real world. Like what sound

waves are used for and they turn into information so that it's not so abstract, like other Math classes that I've had in my life.

11. Can you describe your sense of belonging in your STEM program (are you comfortable in your classes, do you feel you have supportive peers, teachers and administration)?

Not really. But, I'm also in very basic classes right now. So, there are people from all different majors who are working towards a lot of different things. And because I'm in these basic level classes it's not like super STEM specific. Like, it will get there, and maybe not even just here but somewhere if I transfer somewhere else. But it doesn't really feel like anything other than what class I'm in. (9:09)

12. What is your perception of the male to female breakdown (or gender differences) in your STEM classes.

Hmm…it seems (pause) pretty even. I haven't noticed. It hasn't been obvious if it's very different. But, again, I'm also in basic level classes.

Interviewer: OK so we'll call that a "neutral factor?"

Yeah.

a. What were the positive, negative or neutral factors you noticed as a student in the program?

13. What was your experience with campus staff or faculty in the STEM programs?

a. Can you describe further any particularly positive or negative experiences with campus staff or faculty in STEM programs?

I really haven't interacted that much with faculty, staff, anybody about (pause) the program. I went to Math Club meeting once, but the meeting time didn't really work so I

couldn’t keep go back. But that was about as much experience as I’ve had with anyone who hasn’t been one of my professors or an advisor.

14. Do you generally see the same students in your STEM program (do you have a cohort)?

No, nope.

a. If so, can you describe your interactions with your cohort?

b. What is your perspective on the value of the cohort in these programs?

15. What do you know about STEM careers?

No, not really. I had it in my head when I was a child that I was going to be a doctor and do Doctors Without Borders when I grew up and then that disappeared when I stopped liking Science and it came back when I started liking Science again. But, like, when my Math teacher talks about finding oil and how he uses math, I think like there have got to be so many things that I don’t even know exist. And I don’t know what they are. And I don’t know how to figure out what they are either.

a. Does a career in STEM motivate you to complete your college program or stay in the major?

Umm (pause)…I guess? Just because I find science interesting. All over the place. Like every kind of science that I have studied I’ve been like “wow this is amazing!” And to think that I could find a way to put that to a career would be awesome. It would be so much fun. I could talk about science all day with other people who also love science. Like, yeah, that sounds great, but…is that an answer?

Researcher: Sure!

16. What is your perspective on males or females that switch out of your STEM program? In your opinion, what might be the reason for this?

I haven't…I think maybe because I'm in the basic level classes I haven't noticed people moving out of it as a program. Like I've seen people drop out of classes and it seems pretty even. But like I have a friend who when we both started here we were both in Neuroscience major. Because we both were like "science, cool, yes!" And we both have the same advisor who told me "keep going, go for it, do whatever you want" and that I should change my major to Life Sciences because it will be easier for me as a transfer major and that Neuroscience isn't exactly applicable for transfer classes. It would be really interesting, sure, but it wouldn't necessarily help me. And my friend who is in the same major and has all the same, like, background as me, I guess, doesn't have a ton of other college classes with like STEM classes. Her socioeconomic background is different from mine. And the same advisor, with the same information, told her she should think about something more practical. So…she changed her focus and her path because her advisor was like "don't do this, it's not like, it's not going to be sustainable." So, it's really, that was confusing for me. I haven't quite figured out how to reconcile that.

17. What are your future plans for your STEM major after this semester?

Researcher: Do you plan on staying?

Yes.

a. What would you say, overall, has most encouraged you to stay (persist) in the program?

It's interesting. It's like I want to learn the 400-level stuff, but I have to go through the 1, 2 and 3 before I get there. So even though sometimes it's a little easy on something or really hard on something else, I figure if I just get through it, and if I actually learn it by passing

a test then I will be able to get to the things that are even more interesting and applicable to real world situations, in a way that basic level everything is not.

OR

b. What would you say, overall, pushed you to drop out of STEM?

18. Is there any other information about your experiences in STEM college programs at MCCC that you would like to share?

Hmm…it's just so important to have good teachers. In classes where I've had teachers who obviously care about the well-being of their students, and also obviously care about their subject matter, and know how to teach, it has made such a world of difference. The only class I have a huge amount of trouble with it's very clear that this guy would rather be in his work out in the field somewhere rather than teaching to other people. And he doesn't have the language to teach it and whatever, so we end up teaching ourselves a lot. And it just is like kind of confusing in a way it might not necessarily have to be. But like having good teachers makes like such a world of difference.

19. For demographic purposes:

a. What is your specific program of study at MCCC?

Life Sciences.

b. How do you identify in terms of gender?

Female.

c. What is your current semester at MCCC?

Third.

d. How old are you?

Uh..29, it just changed.

Thank you for taking the time to interview with me today about your experiences with technology and STEM programs.

Appendix G

Interview Themes Chart

Interview Themes Chart

Name	Total Phrases	Themes
Amy	Father as a role model Family computer at home Sibling used technology Males pushed to STEM Women pushed to teaching and nursing Father as STEM role model High school had technology Computer classes in school Internet available in high school High school pushed technology High school pushed science No STEM during high school Strong relationship with HS teacher Community service as STEM entry point Going to college for a second career in STEM Advisor pushed away from STEM Self-determined for STEM field Science student Professor is amazing Professor love for subject is motivating Age disconnect from cohort More females in STEM classes than males Gender breakdown in program a neutral factor Poor experience with a professor Professor supportive of students Cohort at college for STEM programs Peer support is helpful Can feel like an outsider with peers STEM careers as motivation to complete Many reasons for dropping out but not gender-related Family issues can cause females to drop Peers and professors as encouraging STEM careers require teamwork, college programs similar	Having technology at home Lack of encouragement in high school Minimal college structures STEM career focus Individual persistence

Brenda	Natural curiosity about technology Computer at home Interest and curiosity about technology Boys encouraged to play videogames Girls not encouraged to use technology Watched males work with technology to learn herself Still feels effects of not being pushed toward technology Computer use in HS Did not receive adequate training in math or science Encouraged to take specialized science class Not given remedial science help Dropped out of HS to have a family Females have to choose career or family, no compromise Knew she wanted STEM Professor encouragement Struggle in college with poor HS math background STEM program very encouraging More males in STEM classes overall Male percentage increases with advanced class levels Males being pushed along to advanced classes Females in lower level classes, prep for "female" majors Females are afraid of math Program encouragement in small ways often Cohort as a support system Passionate for STEM major and STEM career Self-determination Males drop out for boredom Females drop out because they are overwhelmed College program is very encouraging	Having technology at home Lack of encouragement in high school Minimal college structures STEM career focus Individual persistence
Carly	Family, dad and siblings introduced to technology Males expected to understand technology Built things with her dad Tech-Ed and computer class in HS Very basic computer training in HS Lost an interest in STEM in HS HS teachers not engaging Back in college because of self-motivation STEM classes very interesting Very little info given at the college level about STEM Science as real-world application is motivating Was already taking STEM classes before meeting advisor Advisor had not STEM background and not helpful overall Good professors	Having technology at home Lack of encouragement in high school Minimal college structures STEM career focus Individual persistence

Math teacher has been encouraging and guiding
Too early to have a cohort in STEM
Even genders breakdown in basic-level STEM courses
No STEM program interaction besides faculty and advisor
No cohort
No STEM career knowledge
The subject itself is interesting
No class drop pattern noticed
Advisor gave different advice to friend
Plans to stay in STEM
Motivated to stay in STEM by real-world application
Importance of good teachers
Poor teacher was particularly discouraging

Appendix H

IMMACULATA UNIVERSITY RESEARCH ETHICS REVIEW BOARD
REQUEST FOR PROTOCOL REVIEW--REVIEWER'S COMMENTS FORM
(R1297)

Name of Researcher: Yaniv Aronson

Project Title: Female Student Persistence in STEM College Programs

Reviewer's Comments

Your proposal is **Approved**. You may begin your research or collect your data.

PLEASE NOTE THAT THIS APPROVAL IS VALID FOR ONE YEAR **(365 days)** FROM DATE OF SIGNING.

Reviewer's Recommendations:

_____ Exempt __X__ **Approved**

_____Expedited _____ Conditionally Approve

_____Full Review _____ Do Not Approve

Thomas F. O'Brien February 25, 2019

Thomas F. O'Brien, Ph.D., Ed.D. DATE
Chair, Research Ethics Review Board

Date: 3/15/19
Name: Yaniv Aronson
RE: IRB Tracking Number: 220
Protocol Title: Female Student Persistence in STEM College Programs

Review Type: **Expedited**	Action: **Approved**
Study Status: Open to termination/reapplication date	
Beginning Date: 3/15/2019	Ending Date: 3/14/2020

There are five (5) conditions that must be met, or the IRB's approval may be suspended or terminated:

1. No subjects may be involved in any study procedure prior to the IRB approval date or after the expiration date. Principal Investigators (PIs) and sponsors are responsible for initiating Continuing Review proceedings.
2. All unanticipated or serious adverse events must be reported to the IRB.
3. All protocol modifications must be IRB approved prior to implementation, unless they are intended to reduce risk.
4. All protocol deviations must be reported to the IRB.
5. All recruitment materials and methods must be approved by the IRB prior to being used.

If you have any questions concerning this information, please contact David Kowalski at dkowalsk@mc3.edu

Sincerely,

David Kowalski Ph.D., IRB Chair