

Examining the Influence of Close Social Groups on First-Year College Student STEM Major Selection

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This qualitative study investigated how close social groups (family, friends, and educators; FFEs) contribute STEM major selection by undergraduate college students. Through purposeful sampling, four first-year college students at a mid-Atlantic, four-year university were surveyed to determine which group or groups students perceive contributed the greatest influence over their major selection. Interviews explored how and why students believe each social group and subgroup affected their decision. Results indicated family members (particularly mothers) play an early and sustained influence over college STEM major selection. High school educators contribute during the college application period, and college STEM professors influence STEM major persistence. Friends may offer support of STEM selection, but do not directly affect student decision. However, at different points of their educational careers, students perceive FFEs collectively contributed to their STEM major selection.

Keywords: college major, friends, influence, parents, STEM, educators

INTRODUCTION

To maintain superiority in the scientific and technological domains, the United States needs a more STEM-educated populace (Langdon, McKittrick, Beede, Khan, & Doms, 2011). Doing so will produce the next generation of STEM-ready college graduates to fill current and projected job vacancies. Currently, the country lacks enough qualified applicants to meet the demand, as STEM job growth is expected to exceed all other occupations four-fold (Fayer, Lacey, & Watson, 2017). The federal government believes America must foster more effective ways to address this dearth to satisfy workforce projections (Bureau of Labor Statistics, 2018).

Even with a decades-long focus on STEM education, the U.S. Bureau of Labor Statistics (2018) continues to project demand for STEM professionals will outpace the supply of qualified applicants. With 99% of STEM employment in areas which typically require postsecondary education, America must continue to look for ways to increase the number of graduates with STEM degrees (Bureau of Labor Statistics, 2018). To address the shortages in STEM fields, sustaining such interest after high school and during college must remain a focus of educators and researchers (Maltese & Tai, 2011). Educators offer that efforts to increase and maintain student STEM interest may lead to an increased number of college graduates with STEM degrees (Rice, Barth, Guadagno, Smith, & McCallum, 2013).

The term STEM generally refers to a collection of career fields related to science and technology, however there is not an all-inclusive list of related degree programs (Ramaley & Prival, 2002). As a working definition, this study used the list of degrees the National Science Foundation employs for its scholarship programs: biological sciences (except medicine and other clinical fields); physical sciences (such as physics, chemistry, astronomy, and materials science), mathematical sciences, computer and information sciences, and technology areas associated with the aforementioned fields (e.g., biotechnology and information technology).

Researchers have found while many K-12 students have an interest in STEM before entering high school, most college-bound students choose to pursue non-STEM majors (Bergin, 2016; Rice et al., 2013; Robnett & Leaper, 2013). Several researchers have considered how to motivate STEM-interested students toward majoring in STEM fields in college (Freeman, Alston, & Winborne, 2008; Rosenzweig & Wigfield, 2016).

Recent investigations have looked into the relationship between the influence of those close to students (i.e., family, friends, and educators) and intrinsic motivational factors (Nugent et al., 2015; Liao & Ji, 2015). To leverage those who may have the greatest influence over student STEM interest, recent studies have explored the influence close social groups (family, friends, and educators; FFEs) exert on student STEM major selection (Vedder-Weiss & Fortus, 2013; Wang, 2013). However, to determine the impact of FFEs, we must first identify the perceptions of the groups students believe contribute to their decision to major in STEM fields. Knowing how students feel FFEs influenced their college major selection throughout their lives

may suggest ways close social groups might encourage undergraduates to select and persist in STEM majors. For example, Schultheiss, Kress, Manzi, and Glasscock (2001) conducted semi-structured interviews with college students on how close social groups influenced their career decision-making process. However, more research needs to explore how FFEs initially influence STEM major selection and persistence of first-year college students.

Therefore, the purpose of this study was to investigate student perceptions about how FFEs may have affected their college STEM major decision-making process. Though the preceding evidence points to the effect of these groups on student STEM interest, subsequent research needs to identify which group contributes the greatest influence over college major selection and career aspirations. This study adds to this line of research by learning more about how STEM majors perceived these close relationships contributed to their major selection and persistence, how participants interpreted their experiences with FFEs, and what meaning they attributed to those experiences. This study explains how undergraduate STEM majors perceive FFE groups or subgroups contributed to their STEM major selection by answering the following research question: How do STEM majors perceive family, friends and educators influenced their major selection and intent to persist within STEM degree programs? In the theoretical framework, I provide an overview of how social cognitive career theory considers the influence of close social groups on student decisions making and review current literature explaining the effect of each FFE group on student motivational factors and major selection. Finally, results of the study will suggest that students perceive FFEs contribute differing levels of influence at differing points across students' educational development

THEORETICAL FRAMEWORK

This study is grounded in the assumption that students' major selection is reflected by the influence of external groups on intrinsic factors. Self-regulation learning (SRL) theory considers the interaction between such extrinsic factors and their effect on student motivational beliefs and actions. SRL offers the interaction between three processes: personal, behavior, and environmental influences (Zimmerman, 2000). As postulated, each individual factor affects the other two. For example, the environment (e.g., parental support) may affect behavior (e.g., imitation of models) and influence the personal (e.g., beliefs). These interactions have been

found to affect student interest in STEM careers and undergraduates' major selection (Gasiewski, Eagan, Garcia, Hurtado, & Chang, 2012; Maltese & Tai, 2011). Such findings serve as the foundation of social cognitive career theory (SCCT). Using Bandura's (1997) social cognitive theory as a framework, SCCT considers how social barriers and supports affect student's intrinsic motivation and self-efficacy, or belief in one's abilities, particularly as these constructs relate to career development (Lent, Brown, & Hackett, 2000). SCCT seeks to understand the process by which people develop interests for, choose, and succeed in selected educational and occupational fields (Lent, Brown, & Hackett, 1994). As such, SCCT provides an appropriate framework to understand the connection between external factors (e.g., support from family, friends, and educators), and intrinsic factors (e.g., self-efficacy, motivation, and persistence) for students selecting and pursuing a STEM major. The literature below explores the influence of these close social groups and their subsequent impact on student decision-making regarding STEM majors and careers.

LITERATURE REVIEW

A combination of internal (e.g., personal preference) and external factors (e.g., STEM subject enjoyment) often influence student career decisions (Taskinen, Schutte, and Prenzel, 2013). One of these external factors is the influence that close social groups exert on student motivational factors, which lead to the selection of STEM majors and careers (Whitehead & Kitsantas, 2017). For example, students who perceive greater social support from family members, teachers, and friends for STEM subjects have better mathematics and science attitudes and higher self-efficacy in these classes (Rice et al., 2013). Korpershoek, Kuyper, Bosker, and van der Werf (2013) found graduating high school seniors who planned to pursue STEM college majors expressed greater influence from parents, educators, and friends than their non-STEM counterparts. Throughout students' academic careers, family (Pomerantz, Grolnick, & Price, 2005), educators (Vedder-Weiss & Fortus, 2013), and friends (Wentzel, 2005) play an important part in academic motivation and decision-making. Once pinpointed, the contribution of these groups (alone, in pairs, or as one entity) may provide insight on how to support college students (Rice et al., 2013). For example, Liao and Ji (2015) suggest that if parents exude considerable influence on major and career selection, teachers and counselors can encourage parents to

consider student preferences, which have been found to increase student self-efficacy, academic commitment, and career readiness. However, few studies have investigated the effect of close social groups, like parents and siblings (Vedder-Weiss & Fortus, 2013), friends (Nugent et al., 2015), and teachers (Liao & Ji, 2015) on STEM major choice. The following explores what is known about the influence of FFEs on major selection and participation of these students.

Family Members

Parents, siblings, and other family members contribute to student motivation and decision-making, including decisions about choosing a college major (Fan, Williams, & Wolters, 2012). The trend continues even after these students enter college. Rice et al. (2013) found that while college undergraduates perceived support from each FFE group, they reported perceived parental support as the most influential regarding STEM self-efficacy (the individual belief one holds about their abilities and confidence toward successful task completion) and persistence. This finding suggests college undergrads look to family members when making important decisions about STEM major and career choices. Older siblings have also been shown to have an impact of younger sibling career aspirations (Rasheed, 2001), and provide career information and emotional support (Xia, 2016).

Friend Groups

As adolescents progress through high school, friends play a more influential role (Erikson, 1968). Students select friends based on some shared interest and principles (Bandura, 1997). How friends feel about STEM areas contributes to student STEM interest and intent to pursue a STEM major (Rodrigues, Jindal-Snape, & Snape, 2011). Robnett and Leaper (2013) concluded that for adolescents, STEM career interest may be most strongly influenced by those who students consider close friends and when group norms most closely align with their own values. The more their friends support and show interest in STEM areas, the more the student feels motivated to pursue a STEM degree (Cohen & Garcia, 2008).

Educators

By the time students begin college, they typically spend more than 15,000 hours with educators (teachers, counselors, administrators, etc.) in a school setting (Deci, Vallerand, Pelletier, & Ryan, 1991). Therefore, it appears logical that students perceive how well educators

prepared them for mathematics and science (Wang, 2013) and level of teacher support (Rice et al., 2013) may affect their likelihood to pursue STEM degrees. Also, findings indicate the cumulative effect (i.e., over a student's entire K-12 career) of positive STEM teacher influence may increase STEM self-efficacy and motivation toward a STEM career (Wang & Degol, 2013). This effect continues into college where professor interaction has been shown to affect STEM motivation and persistence (Hiebert & Grouws, 2007).

Intrinsic Motivational Factors

As Bronfenbrenner and Morris (1998) offer, those social groups that interact most often with students will likely influence their decisions. Educational researchers (Robnett & Leaper, 2013) have long studied ways to leverage these close social groups to bolster STEM interest and persistence in students. Such studies have focused on undergraduates pursuing STEM degrees (Lent, Ezeofor, Morrison, Penn, & Ireland, 2016). Results demonstrate there exists a relationship between STEM interest, self-efficacy, FFE support, and STEM major persistence. Findings from recent studies (Korpershoek, Kuyper, Bosker, & van der Werf, 2013) also found support for STEM subjects from family members, friends and educators led to positive student motivational beliefs.

Social group support works with intrinsic factors to maintain STEM selection and persistence. When combined with increased support from social groups, Lent and colleagues found that increased self-efficacy helped sustain interest in undergraduate STEM majors, such as computing and engineering (Lent et al., 2011; 2005). These researchers also linked intention to persist in the computing field directly to level of social support, social barriers, self-efficacy, and interest. Further, when mediated by STEM self-efficacy, STEM interest has been shown to predict levels of STEM learning.

Several studies (Lent et al., 2015; Rosenzweig & Wigfield, 2016) also investigate the effect of these intrinsic and external factors on STEM career interest and choice. The same aforementioned Lent et al. (2011) study also noted that, when mediated by career outcome expectation, STEM interest was shown to predict student likelihood to pursue STEM careers (Nugent et al., 2015). Similarly, self-efficacy partially-mediated the effect between social supports and barriers, and mathematics-related career choices (Gainor & Lent, 1998). STEM

self-efficacy had a similar mediating effect between social supports and barriers, and intent to persist toward STEM careers (Gainor & Lent, 1998). However, rather than researching effects of social supports on self-efficacy, other studies considered these factors circuitously. Lent et al. (2015) found social support and STEM self-efficacy have a reciprocal effect on one another while studying college engineering students. In other words, they concluded the more support students receive from FFEs, the higher their STEM self-efficacy; and the higher their STEM self-efficacy, the greater the likelihood students would seek and receive FFE support. Finally, those students who received FFE support for academics also had higher STEM self-efficacy and expected better outcomes in pursuit of their engineering degrees. Based on these results, newer SCCT models now consider social supports (i.e., FFEs) as important variables when investigating STEM career intent and persistence (Lent et al., 2011).

While literature supports that FFEs contribute to the STEM major selection of first-year college students, there is little research on how students perceive the meaningful roles that subgroups of these larger categories play. Moreover, entering college is an important transition time--new friend groups emerge as older groups wane. Also, parental influence and control may diminish, and siblings are oftentimes separated. Understanding perceived influencers at this time of change is important as new systems of supports develop. Finally, though students may attribute college STEM major selection to a certain macro FFE group, interviews may uncover this decision actually developed from specific childhood experiences or continuous implicit influence.

METHODS AND PROCEDURES

After considering my ontological (post-positivist) and epistemological (constructivist) stance, I realized the questions in which I am interested lend themselves to a basic qualitative study (Maxwell, 2008). Therefore, to better understand participants' perceptions of how close social groups influenced STEM major selection and persistence, I used a basic qualitative design (Maxwell, 2008). Per Maxwell (2008), basic qualitative design allows researchers to determine how participants interpreted their experiences and what meaning they attribute to those experiences. In this case, the design of the study was focused on investigating how the students interpreted the influence of others when selecting a college STEM major.

Participants and Setting

The four participants were first-year students majoring, or planning to major, in a STEM degree program at a large, four-year public university located in the mid-Atlantic part of the country (see Table 1). Prior to participant recruitment, I obtained approval to research human participants from the university's Institutional Review Board. I selected participants for the study based on their responses to survey items, as part of a larger quantitative study which asked students to rank order the level of influence from family members, friends, or educators on their choice of major. The last survey question asked if participants would be willing to take part in a 30-minute interview for a chance to win a \$25 university bookstore gift card. I analyzed those who consented to the interview ($n = 48$) to determine to which FFE category students attributed the greatest influence on their STEM major selection.

I deemed those respondents who identified the respective group (i.e., family, friends, or educators) as most influential ($n=12$) as the ideal pool of potential participants. Using purposeful sampling, I reviewed potential participants' demographic information to ensure participants reflected a diversity of majors, gender, race, and cultural backgrounds. I sent interview requests via email to three potential participants to arrange a date, time, and location. When students did not reply, I sent interview requests to a second set of respondents, who identified the same FFE group as most influential until each group was represented.

As a result, I sent five email invitations; of those invitations, four participants were interviewed. I sent the fifth participant a follow-up invitation, three days after the first invitation but did not receive a response. The four participants represented a cross-section of STEM majors, gender identities, racial/ethnic backgrounds, sibling order, and most influential FFE group (see Table 1). Three students came from households where neither parent held a college degree; of those, one's mother currently attends college. Both parents of the other participant each have a degree. Two students are first-generation Americans, where both parents immigrated to the United States. All interviewed students had at least one sibling.

CLOSE SOCIAL GROUP INFLUENCE ON STEM MAJOR SELECTION

Table 1

Participant demographics

Name	Major	Gender	Race/ Culture	Sibling order	Siblings	Influence recorded on survey (comparative ranking)		
						Family	Friend groups	Educators
Sydney	Biology	F	AA	Middle	OB, YB	2	3	1
Anna	Computer Science	F	Asian/ Latina	Oldest	YB	3	1	2
Martin	Forensic Science	M	Cau	Oldest	YS	3	2	1
Nora	Biology	F	AA	Young est	OS, OB	1	2	3

Note: F=female, M=male, AA=African American, Cau=Caucasian, OB=older brother, YB=younger brother, OS=older sister, YS=younger sister; Comparative ranking: 1 most influential, 3 least influential

Data Collection

To encourage participants to describe their own path of major selection, I used an open-ended interview protocol that I developed in an earlier pilot study, which investigated the major selection of undergraduate students across STEM and non-STEM majors (Whitehead & Kitsantas, 2017). I made refinements to the interview protocol to focus questions for STEM majors solely and examine FFE subgroups. I honed questions to develop a picture of how participants considered inputs from close social groups to determine college STEM majors.

I outlined questions to begin with a broad investigation of major selection, then an exploration of how close social groups affected that decision. The interviews ranged in length from 14 to 24 minutes, lasting an average of 20 minutes. All interviews took place in a private conference room in the university library. I asked each participant comparable questions based on the interview protocol. The interviews were semi-structured covering two topics: a) factors considered during their major selection process, and b) ways FFEs influenced, and may influence in the future, their major decision. Open-ended questions such as, “Tell me how those close to you affected the decision for your major,” encouraged participants’ reflections on how FFEs may have influenced their STEM major selection (see Appendix A). Prompts were used for

clarification of questions or to follow-up to participant statements. Participants who completed the interview were entered into a drawing for a \$25 gift card to the university bookstore. The drawing took place two months after the last interview, and I notified all participants via email when a winner was randomly selected.

I recorded the interviews using the Audacity application on my laptop computer. During the interview, I prepared field notes to record impressions about the participant (e.g., demeanor) and any other noteworthy observations. Immediately following an interview, I created field notes and annotated any preliminary connections between the current and previous participants. Next, I listened to the complete interviews twice more, adding to field notes as necessary, and developed preliminary open codes (Maxwell, 2013). Then, I uploaded all interview audio files to a transcription service website. Full transcriptions were received within 14 hours.

Data Analysis

I analyzed interviews line-by-line using an open coding scheme, to identify categories and to review influence of each social group. I reviewed and analyzed each interview separately to mitigate influence from subsequent interviews. Initial analysis resulted in 355 codes. When all interviews were coded, I placed all codes into a Microsoft Excel spreadsheet. Each column listed the codes under the respective participant pseudonym. Next, I reviewed all participant codes and field notes to gain an overall impression of each participant. This within- and across-participant review resulted in 19 overarching categories (see Table 2). Finally, analysis of these larger categories resulted in four themes. The themes were entered into another spreadsheet. Columns were created for each participant and relevant exemplars for each theme were recorded on the appropriate row for each theme. Initially, lines were analyzed to identify which group or subgroup had the greatest or least influence. However, early analysis suggested an interplay between FFE groups contributed to participant decision-making. Therefore, I coded interviews again looking for examples where students discussed how FFEs' inputs contributed to their major selection, either deliberately or inadvertently.

Table 2

Secondary coding categories

Secondary codes	Preliminary categories
Attribution	Hard work Achievement attributed to effort
Siblings	Older sibling influence Model for younger sibling Older sibs feel obligation to direct or encourage younger sib career or education path
Parents	Parents set early environment conducive for exploration Early exposure to STEM from parents Parents college attendance Immigrant parents push career prestige and success Mom took to activities while dad working
Friends	Friends have similar career goals Sense of STEM community but each said friends played no influence on choice
Educators	EDs provide opportunity and mechanism for STEM major
Difficulty	Varying difficulty across STEM majors Differences between STEM majors
Career	Salary and employment drove career decisions For some interest predated career Others career interest precipitated STEM interest
STEM	Interest in more than one STEM subject

Trustworthiness

To improve the trustworthiness of the study, different techniques were used. Increasing validity of the qualitative analysis began in the design phase with the interview protocol construction and continued through data collection and analysis. The protocol used semi-structured open-ended prompts to allow participants to answer the question as they chose. Each interview was audio recorded, listened to three times, and transcribed verbatim by a professional firm to ensure data accuracy. Data was also analyzed using various procedures. Line-by-line

open coding ensured full interpretation of interviews and minimized the impact of the researcher's particular interests. Similarly, an interpretive community of educational psychology doctoral students and researchers provided analytical feedback during the design and analysis phases, providing diverse insights on the findings and minimizing the potential impact of a single researcher's bias.

Positionality

My own upbringing may affect my understanding and impressions regarding how close social groups may influence STEM majors and careers. In the eighth grade, students in my hometown had the option to take a city-wide aptitude test to attend one of three prestigious STEM high schools. Due to a strong academic record in elementary and middle school (and a demonstrated interest in science up until that point), my parents, aunts, and grandparents pushed me to take the test. Their insistence, while constant and unrelenting, may have only played a small portion in my decision to attend one of those schools. Having both parents working in medical fields, and high-salary jobs available in STEM fields, already served as motivation to attend one of these high schools. However, once in the school, I perceived teachers only supported and encouraged students with the highest grades. In my case, though the motivation was present, my grades hovered in the average range. While some friends excelled, their success and tutoring were not enough to drive me to study harder; my STEM interest waned. I was quickly discouraged and committed to pursue a non-STEM college major. Though earning non-STEM degrees, my STEM interest returned when I entered the workforce. For many years, I worked in STEM-focused companies and offices. When I became a father, I closely observed the activities and academic successes of my children to support their interest. Due to my daughter's slant toward STEM fields, I recommended certain classes and extracurricular activities. My son, who expresses little interest in STEM classes, applies a scientific approach to his artwork. As a result, both enjoy classes and activities which require systematic approaches, such as learning languages and puzzles.

I believe my K-12 experiences and parenting style may both impact analysis of this study. To lessen these effects, I offered to send a transcription of their respective interviews to

participants. Also, to address possible biases, I consulted other educational doctoral students and researchers during the design, data collection, and data analysis portions of this investigation.

FINDINGS

This study drew on the perceptions of first-semester college students who major in STEM fields to explore how close social groups influenced their undergraduate major choices. These reflections provided an understanding of FFEs impact STEM major choices and persistence early and throughout their educational careers. The following findings outline how new college students perceive FFEs contributed to major selection based on participant narratives.

Family Constitutes a Distributed Group Affecting Childhood STEM Interest

Starting early in a student's education, family members may foster STEM interests. Each of the participants conveyed stories of how several types of family members – parents, older and younger siblings, aunts, or other relatives – played some role in their interest in STEM fields. As Sydney said:

We did go to museums, because I love museums. And, my aunts also took me to museums. My mom would take me to the aquarium . . . in, like first grade or kindergarten, I was, like, "I wanna do that" I said, "I want to be a person that works with dolphins." And my mom was like, "Okay, so you want to be a marine biologist."

In addition to taking the student on field trips, older family members modeling STEM careers also had an influence on participants. As Nora said, "My mom's side of the family . . . almost all of her sibling are doctors." In these cases, the examples set by elders fan the embers of student STEM interest.

Family members influenced STEM pursuits directly (e.g., transporting to field trips and holding STEM positions) and indirectly (e.g., encouraging students to enroll in additional STEM courses or to find a STEM mentor). For some participants, family members that simply allowed them to participate in extracurricular activities or advising them to seek mentorship from STEM teachers demonstrated support of their interest in STEM. For example, Anna stated that her mother, a stay-at-home mom who did not attend college, "wouldn't actually take me, [but] would always provide a means to get to [STEM activities]. Things like money, transportation . . . she

didn't [attend], but she really pushed me to go with other people, so she pushed me towards mentors . . . teachers." Similarly, Martin, who decided to major in forensic science his sophomore year of high school, believes his decision to pursue STEM began before a middle school trip: "Eighth grade, I came down for a Johns Hopkins trip to the International Spy Museum . . . It might have even been earlier than that 'cause I knew going into that . . . I was like, this is going to be so cool. So . . . it's been a long time." In addition to encouraging STEM-based activities, growing up seeing older family members' STEM pursuits may plant seeds early on.

Having older siblings who push STEM, or other relatives' STEM careers, may make the prospect for younger family members more real. Older sibling participants seemed to encourage younger siblings toward STEM-related fields. Sydney, a middle child, spoke about her older brother's affinity for computer gaming and the likelihood that she would encourage STEM-based classes and hobbies for her toddler brother: "Of course, I'd push him into whatever he wants to do, but I want him to do something more science-y." Likewise, while searching for a common interest to share with her younger brother, Anna changed from an interest in engineering to computer science:

I took him with me to a lot of [coding competitions], initially for him. So, all the coding competitions, I had pushed him towards those, and then I decided that I like them as well . . . I was trying to get into his interests so we could better connect, and we kind of ended up merging together. We both wanted to do the same thing now . . . [I] probably contributed to his interest in computer science.

While older siblings seem to want to encourage the individual interests of younger siblings, they also appear to want their younger siblings to pursue STEM careers.

Yet, for Nora, an older sister who graduated medical school offered different advice: "She was trying to steer me away from that. She told me that it takes a lot out of you and unless you're really 110% sure that you want to end up doing that, then don't commit to it." Regardless of this advice, the influence of other family members may have swayed Nora to pursue a medical career. Both parents encourage that path, and several aunts and uncles (who are themselves physicians) refer to her as Dr. Nora, "because in their heads, it's set and done."

While some interview participants recognized an importance to respecting their parents' wishes and efforts, some felt driven, intrinsically, to earn their chosen STEM degree. Nora remarked, "My parents . . . sacrificed a lot for me and I would like to please them, but not to the point of doing something as outrageous as . . . going into a field that I have absolutely no interest in." Likewise, Anna noted her immigrant mother had fixed ideas about women in an information technology (IT) field, categorizing her as "very traditional." However, her mother's view, "hasn't really been a deterrent for me."

In sum, while all four participants noted familial influence on their STEM interests, some reported a more distributed influence with aunts, parents and siblings playing meaningful roles, others prioritized the influence of a single parent (i.e., their mother). Likewise, influence played out in both direct and indirect ways; particularly of note were examples where parents who did not feel knowledgeable about STEM used their influence to encourage their children towards mentors suggesting a complimentary relationship amongst the FFE groups.

Educators Sway STEM Major selection and Degree Persistence

With an established interest in pursuing a STEM degree, participants looked to educators when selecting a STEM major in college. Each participant stated they knew when it was time for college applications, they would apply under a STEM program. However, they also described how high school STEM teachers affected the specific STEM major for which they would apply. With her father in the military, Anna spent her first two years of high school overseas, resulting in limited STEM classes. To satisfy her STEM interest, she took AP biology and AP chemistry, because, "they didn't have AP computer science." Once she transferred to an American high school, Anna had more STEM options and more STEM teachers:

I met a computer science teacher, and I started programming, and I started participating in hack-a-thons and different competitions . . . and that's what really started my interest in computer science and programing. . . . It was the teachers mostly. So, it wasn't until I moved to America, and I was introduced to a computer lab, computer science in general, that it was more suited towards me than engineering. Engineering was like the quick fix. There was limited resources, that's all I had.

Therefore, though Anna had early interest in STEM areas, increased access to more STEM classes, paired with her teacher's influence, appears to have contributed to her eventual college major.

Yet, having teachers who made class content interesting did not always lead to students majoring in that subject. Martin remembered, "My most memorable teachers were English and history teachers. They made that fun for me. . . . I had a set of really good teachers, so that got me through it." However, these teachers' effectiveness aside, Martin knew:

What I wanted to do by sophomore year. I knew I definitely wanted to pursue science, and I didn't get down to the nitty-gritty until applying and stuff . . . but I've been set on science for a while.

A common refrain among participants was an idea that between middle and high school, they decided to pursue a STEM career. However, this intent to pursue STEM were more focused on a career goal, rather than the major. This distinction may speak to the idea that a college STEM major and degree serve as a hurdle between initial interest and a STEM career.

In some cases, the STEM major participants selected entering college changed because of their college instructors. One participant believed college STEM professors may directly affect her likelihood to complete STEM degrees. After entering college as a chemistry major, Sydney's difficulty with her introductory chemistry professor, and interactions with biology professors in a pre-college summer camp, prompted her to change her intended major:

The STEM boot camp helped a lot...Dr. Kingston [pseudonym] and Dr. Wilson [pseudonym] are just amazing and I was like okay if that's the representation of the bio department then good for me. Changing my major has everything to do with the [chemistry] professor; when I changed from chem to bio. My bio professor was so much better. I like the bio department way more than the chem department because I feel like the chemists talk over my head a little bit. They already understand the concepts and it's kinda hard to explain once you really understand things in chemistry. . . . I don't fault them for that but I feel like bio, I will learn more and I can learn better. . . . So, yeah, it's all about the professor.

Sydney reiterated the influence STEM professors have on her degree persistence when she was asked if there were anyone in her life that may persuade her to change to a non-STEM major: “A professor. They can say I'm not good at it. And I'll be like okay I need to go into something that I'm better at.” This sentiment differed from other participants. When asked the same question, Martin offered, “I don't let other people deter me once the mind's set.”

In sum, the influence of educators may sometimes emphasize their more sophisticated knowledge of STEM areas. In some cases, this may manifest as helping students choose amongst STEM majors. Other times, it may be more an influence of personality and teacher effectiveness, such as Sydney's switch from chemistry to biology, based on her relationships with the particular professors.

STEM Friends Help Sustain Interest but Not Direct Influencers

All four participants shared that the majority of, if not all, their friends entered college pursuing STEM degrees. In some cases, these relationships grew out of shared interest in STEM high school activities. Anna explained that she would “go to all the coding competitions” with someone who became her best friend. She felt that, attending computer science competitions, “got me these friends that got me more into (computer science).” However, when deciding on a major for college, Anna reiterates that friends, “weren't a huge deciding factor.” Similarly, Martin has “one really good friend who's a forensics major” at a different school, but she played virtually no role in his decision. Though some friends were carried forward from high school, others have been established during college.

Some participants developed new STEM friends upon entering college. For Nora, support from a friend studying biology came in the form of academic instruction. A friend she met in high school, and continues into college, helps her understand some science concepts. She offered, “The person that is actually in my current biology class was also in my last two biology classes in high school and we used to study together. The way she explained things just made it seem so easy.” Sydney agreed that most of her friends share STEM interest remarking, “Basically all of my friends have something to do with science. Whether it's physics, bio, chem.” This sentiment was echoed by Anna who said her friends were, “STEM related mostly. I don't

have too many friends who are art majors or things like that.” Friends may provide some level of encouragement or other support. Nora explained:

I dated a guy who was really into biology, and we spent a lot of time studying together. I guess, that sort of influenced me when I went to biology. Just the fact that he was also doing it . . . We study together all the time. But, I guess that he was also there pushing me, “Go that route.” Telling me why it would be a good thing.

Though each participant stated an early intent to pursue a STEM major, supporting STEM friend groups may have added to their persistence within those areas.

Others Support May Turn General STEM Interest into Major Selection

The intellectual and emotional backing of FFEs may cultivate early STEM interest into continued pursuit. Over time, encouragement and support from FFEs might help students consider and decide on a college STEM major. Each participant expressed an individual, intrinsic drive for a STEM major, yet also discussed how FFEs played a role in nurturing an already-existing curiosity in STEM areas.

For Anna, who knew she wanted a career in STEM during elementary school, a confluence of FFE supports led to her majoring in computer science. As mentioned, though her mother provided financial and logistic support, being new to the country and her limited formal education provided some challenges. However, Anna’s mother encouraged Anna to seek educators, friends, and STEM professionals to serve as mentors. Ultimately, this combination contributed to her major decision: “Computer science was chosen because I was influenced by my professors who pushed me towards these competitions, who got me these friends, who got me more into it.” Similarly, Sydney believes she, “played the biggest role in choosing my major” because she always wanted to pursue a career in biology, but admits her parents, “pushed science because they [knew] that I’ve always liked science.” Martin, too, expressed his major selection as, “my choice . . . I’m making my own path;” though he spoke repeatedly about how his parents encouraged his middle school trip to learn about forensics, a high school teacher who exposed him to forensics field work, and a close friend who also majors in forensics science. Likewise, Nora (the biology major who intends to attend medical school) described several older family

members who work as physicians, a boyfriend and high school friend who major in biology, her most influential high school teacher, a biology teacher who “made it seem so simple”, and a plan to earn an internship to “shadow a doctor . . . to see what it’s like.”

DISCUSSION

Studying students as they enter college allows them to reflect on their major decision-making process while it remains fresh in their minds. This investigation offers that FFEs provide differing levels of influence throughout the major selection process. As the influence of family members may begin to fade, and high school friends continue through their own postsecondary experiences, new friend groups and college educators may gradually affect student decisions. This appears an ideal point at which to ask students about how those closest to them contributed to major selection.

Researchers (Liao & Ji, 2015; Maltese & Tai, 2011; Pinxten et al., 2015) have continuously investigated and found FFEs influence undergraduate students’ STEM major selection. Though this study had comparable results, findings suggest that students perceive family members, friend groups, and educators exert differing levels of influence at different points of a students’ educational career. First-year college students expressed that FFEs work together to affect their motivation toward major pursuit and intent to earn a STEM degree. However, while FFEs may provide influence and support, these first-year college students suggest their internal interest and drive led to the decision for a STEM major.

The influence of close family members seems to begin early and continue throughout a student’s development. Starting in students’ elementary education, parents, siblings, and other close relatives may inspire children to pursue STEM careers. It appears that one parent and a diverse group of family members may offer modeling and support that may affect their STEM degree interests. That is, though students may attribute a visit to the aquarium with their mother as a driver for a STEM career, a father’s conversation about future careers, or having aunts who work as physicians, may have a cumulative effect on STEM interest. Further, parents may encourage students to take certain classes to enhance an already burgeoning STEM curiosity. These findings support Gottfried et al. (2016) who observed parental encouragement of

elementary children contributed to sustained STEM motivation and pursuits. As students develop through school, these early influencers may plant a seed that educators are prime to nurture.

Students appear to solicit and rely on inputs on major selection from educators during high school and early college years. Friends who share an interest in STEM fields appear to offer a level of support and encourage an already burgeoning level of interest. However, these findings suggest a lesser role compared to family members and educators. Friends may offer an additional, yet less direct, form of support for those considering, or already leaning towards, STEM majors. STEM friend groups may offer an acceptance and shared interest that could help students persist in these areas in the face of challenges. Similarly, (Gottfried et al., 2016) highlighted that friends contribute to student career aspirations, but at a much lower rate than parents, SES level, or prior achievement.

The overall conclusions gleaned from the study suggest that undergraduate STEM first-year students perceive their major selection derived from a combination of FFE influences and their own intrinsic drivers. Family members seem to foster and maintain early STEM career interest from early childhood through middle school years. Next, in support of Bandura's (1989) theory on child development, as students begin to exert independence from parents, friends and high school teachers may affect first-year student major selection. This study provides some initial insights into how what the dynamic and shifting set of influences of family members, friends, and educators may affect early STEM major selection.

EDUCATIONAL IMPLICATIONS, LIMITATIONS, AND DIRECTIONS FOR FUTURE RESEARCH

From initial exposure of material by parents and teachers, to support from friends and other educators, sustained interest in academic areas requires influence from close social groups (Bergin, 2016). Recruitment and support of STEM-interested high school and college students requires a team approach from university personnel, teachers, professors, family, and friends (Cridge & Cridge, 2015). Understanding the effect that each close social group and their combined effect, on undergraduates' decision to major in STEM fields. Therefore, findings of the present study may help high school academic and career counselors and college admissions professionals to partner with family members, professors, and friend groups during the selection of college majors. Once in college, these insights could also assist college academic advisors and

instructors to encourage greater persistence toward degree attainment, especially for those in STEM programs. Insights from these findings can also help educators advise parents on how to best support students when they face academic challenges and boost their self-efficacy beliefs.

There were a number of limitations to this investigation. First, there were only four participants. Though efforts were made to represent different majors, races, and gender identities, so few interview participants make it difficult to fully investigate student perceptions of FFE influence. Further, this study only considered first-year college students during their first month in college. The surveys were administered within the first month of the school year, a time when students are acclimating to a new academic environment (and possibly new living, geographic, social, and emotional surroundings). Though essential to garner student perceptions transitioning from high school to college, participant perspective may derive from these new settings. Also, the research design assumes each of the FFE groups have some influence on major selection. Though the interview protocol allowed participants to articulate their major selection as they saw fit, the prompts focused on FFE groups only. Prompts did not offer the influences of significant others, sport coaches, mass media (e.g., television shows or movies), or celebrities (e.g., prominent STEM figures). Finally, given that students will likely change majors during the first two years in college (Seymour, 1995), with many of those selecting non-STEM majors after struggling with introductory science, engineering, and mathematics courses, participants in this study would not have experienced these classes by the time of survey.

Subsequent research in this area should consider the role that other close social groups may play on STEM major selection and persistence. For example, this study did not consider the influence of relationships with boyfriends or girlfriends, or athletic or sport coaches. Also, since socioeconomic status has been found to affect several areas within educational psychology (achievement, major and career selection; Carpi, Ronan, Falconer, & Lents, 2017; Cleary & Kitsantas, 2017), future studies should investigate the effect SES may add to STEM major selection.

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APPENDIX A

Interview protocol

- Walk me through the process you used to pick your college major?
- Tell me how those close to you affected the decision for your major.
 - Family members, friends, teachers, counselors
 - Tell me how your family talked to you about your college major.
- Any other influences on your choice of major you think it is important for me to know about?
- How would you complete the statement, “I chose to major in X because...”
- What may influence you to change your major
 - Is there anything anyone could say?
 - (Based on their Top 3), Is there anything your X could say?
- Is there anything else you'd like to add that would help me understand your thinking around your college major?

Topics/Covert Categories

- Factors influencing major selection
- How do they define influence?
- Were there specific events that affected major selection?
- Were there specific events that affected pursuit of STEM major?
- Who do they prioritize?
- What made you tell me that story?