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EXAMINING HIGH SCHOOL STUDENTS' SCIENTIFIC IDENTITY AND INTEREST IN
STEM CAREERS AFTER PARTICIPATING IN AN AFTERSCHOOL BIOSCIENCE
COURSE

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ABSTRACT

EXAMINING HIGH SCHOOL STUDENTS' SCIENTIFIC IDENTITY AND INTEREST IN STEM CAREERS AFTER PARTICIPATING IN AN AFTERSCHOOL BIOSCIENCE COURSE

STEPHANIE L. RAINS

Identity and self-efficacy play a role in understanding how students commit to entering science, technology, engineering, and math (STEM) careers. Since there is such a small percentage of underrepresented students in STEM fields, a shift needs to occur in order to encourage and motivate underrepresented students to commit to STEM. The purpose of this study was to observe two male students from differing cultural backgrounds in a bioscience class, and how their scientific identity and self-efficacy determined career goals. Through non-traditional classrooms such as project-based learning (PBL) classes, students are able to gain a better understanding of science. PBL classes, such as the bioscience class these students participated in, immerse students in research, foster relationships with professionals and peers, and provide a community to students that cannot be given elsewhere. As a result, the Caucasian student, with a strong STEM background and interest in going into a STEM field, displayed little to no further formation of scientific identity. The Native American student, however, entered the class interested in a STEM field, yet was given the opportunity to experience and observe a variety of STEM fields, forming a scientific identity, therefore causing him to pursue more STEM opportunities and fields. Because of the rigorous, student-centered environment this bioscience class provides, along with the community partnerships and mentorships, helps students develop a positive STEM identity and increased STEM self-efficacy, which motivates students to pursue STEM related fields.

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Key Terms: Community partnerships, Identity, Project-Based Learning, Self-efficacy, STEM, Underrepresented

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Examining High School Students' Scientific Identity and Interest in STEM Careers after Participating in an Afterschool Bioscience Course

A lingering question in the scientific community is why is there a lack of underrepresented students in science, technology, engineering, and math (STEM) fields, and what can be done to improve this? Low percentages of underrepresented students presence within STEM fields has been an ongoing issue (NSF, 2014, tab5-6). Research shows it is not solely due to lack of persistence in STEM, yet is a lack of persistence within higher education that has been the problem (Lord, Camacho, Layton, Long, Ohland, & Washburn, 2009). This issue begs the question as to how educators can motivate students and create student engagement within STEM. Ultimately, research shows student identity and self-efficacy are two main influential factors in determining academic goals, therefore development of these factors could create persistence within STEM and higher education.

Identity and self-efficacy have been shown to be a major contributing factor to enter any field of work. Scientific identity is developed with the help of mentors such as teachers, community partners, and prominent scientific community members, as well as experiences within science (Brickhouse & Potter, 2001; Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011). Students who are exposed and actively interacting with these factors develop a sense of self-efficacy, an ability to plan and execute a course of action to reach a goal, within science. Once students have developed this sense of self-efficacy, a likely outcome would be for that student to enter a STEM career (Chemers et al., 2011).

The importance of understanding the link between identity and entering STEM careers has been an area of research that flourishes empirically, yet has little to do with what actually happens within the classroom. Though few studies have been conducted on the link between

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scientific identity and STEM careers, even fewer have researched the development of scientific identity in underrepresented students (Blustein, et al., 2013; Brickhouse & Potter, 2001). Giving students the opportunity to participate in research experience, network with STEM professionals, and resources to gain self-efficacy and develop a scientific identity could be extremely beneficial to obtaining a higher presence of underrepresented students within STEM. My research would add to the literature of how developing scientific identity and self-efficacy impacts the link between classroom environment and positive outcomes to enter STEM careers in underrepresented students.

This case study created a narrative for two male students from different cultural and academic background who were involved in a student-centered, non-traditional bioscience class. Over the course of a year, these students were involved in a project-based learning (PBL) bioscience class, allowing students the opportunity to link phenomenon to real world problems (Bell, 2010; Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991). One major component the bioscience class implements is community partnerships, which is an important factor in developing scientific identity because it provides the opportunity for students to work alongside STEM professionals, creating a sense of place among scientists (Chemers et al., 2011; Gandara & Maxwell-Jolly, 1999). Through these community partnerships, students worked with prominent STEM professionals within the community to solve a local problem.

The purpose of this study is to understand how scientific identity evolves in two high school students from differing cultural and academic backgrounds, and how self-efficacy influences their decisions to enter a STEM field when participating in a PBL bioscience class partnering with community members. An exploratory sequential case study was conducted to collect data for analysis and interpretation. The main research question is:

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1. To what extent does the scientific identity of two high school students participating in afterschool bioscience course develop over a school year?
 - a. What are the differences in scientific identity development between an underrepresented minority student and a Caucasian student?
 - b. In what ways do the students' self-efficacy, interest, and motivation to enter a STEM career evolve?

Review of the Literature

Understanding student interest and motivation to commit to science, technology, engineering, and math (STEM) careers is crucial to the promotion of underrepresented students within these careers (Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011). Underrepresented students, such as African American, Hispanics, and Native Americans, within STEM fields have a much lower presence compared to their White and Asian counterparts (NSF, 2008 table c-14). In order to remedy this inequity, many underrepresented students are given the opportunity to participate in science programs, yet the problem is many of these science programs severely lack in rigor (Chemers et al., 2011). Appropriately designed and implemented science programs outside of school lead to higher success and persistence within STEM classes and careers (Chemers et al., 2011; Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2008).

Science programs such as project-based learning (PBL) classes outside of school give students the appropriate resources and experiences, as they are centered around the student's natural curiosity (Bell, 2010). Not only do these classes immerse students in their own curiosities, but they also allow students to experience science in the real world, related to their real problems (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991). Having these two aspects affirms a stronger understanding of science, and a motivation to commit to STEM

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careers. As students engage in real world issues through scientific procedures, students develop a sense of scientific identity and are motivated to enter STEM careers.

Identity-Based Motivation

Self and identity, though extensively researched by psychologists and sociologists, can neither be concretely defined nor succinctly conceptualized (Leary & Tangney, 2003).

According to Oyserman, Lewis, Yan, Fisher, O'Donnell, & Horowitz (2017), identity can be assumed to mean that motivation and behavior matter because of who one is, that individuals know themselves more than anyone, and because people always think of themselves, they can predict what they will do in the future. This Identity-Based Motivation (IBM) theory tries to tackle these assumptions by seeing identity as more contextual (Oyserman et al., 2017). This theory means that instead of identity being rigid, identity is flexible and can be used to make sense of the world around oneself. For the sake of this literature review, identity will be used as either personal, where one defines themselves in terms of characteristics and traits, or social, where one defines himself or herself in a social relationship, role, or group membership (Oyserman et al., 2017; Hogg & Turner 1987). Both social and personal identity is contextual and therefore help define the world around them.

Oyserman (2015) makes the argument that self and identity are able to shape behavior. Through the measure of IBM, one's sense of identity is mostly discerned through identity dynamically constructed in context, behavior that is influenced by moments in time, and difficulty applying change in identity (Oyserman et al., 2017). As a person thinks about identity, there is a matter of context this identity will be thought around, and responding to that identity depends on that context. Within that context, it is important to understand the relationships surrounding self, identifying who influences and understands self, such as parents and friends.

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Self, on the other hand, is a perception of examining the relationship between identity and self-concepts (Oyserman et al., 2017). Here, Oyserman et al. (2017) consider identity as the way one understands the surrounding world and self-concept as cognitive structures in order to categorize identity. Regulating self requires regulating this relationship, so how one will attend to feelings, how they will display these feelings, and how they will act are considered self-regulation (Oyserman et al., 2017). For example, self-regulation strategies can include encouraging words to oneself, or telling oneself to pay attention. Being able to self-regulate is crucial in achieving personal and academic goals as shown in figure 1 (Oyserman, Bybee, Terry, & Hart-Johnson, 2004).

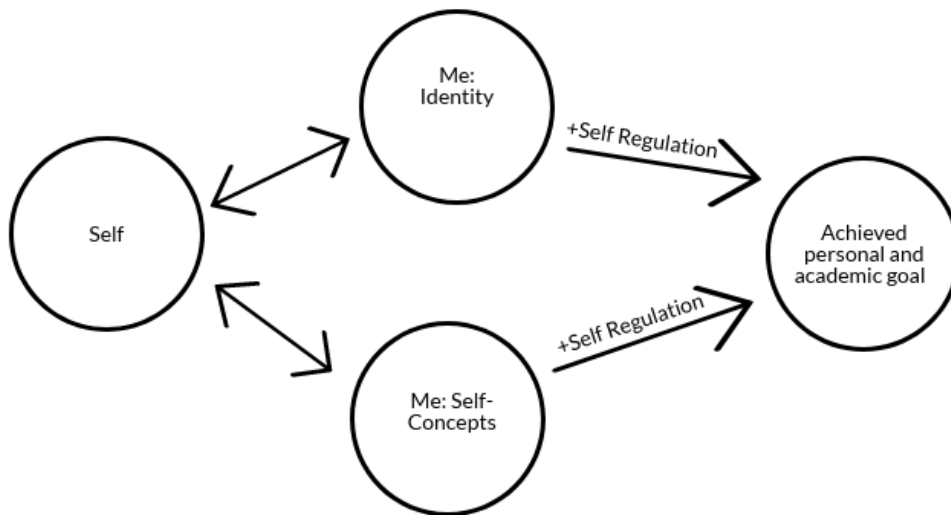


Figure 1. Flow chart of identity in relation to goals. Self flows between identity and self-concept. When identity and self-concepts are both regulated, one will achieve personal and academic goals. Adapted from (Oyserman et al., 2017; Oyserman, Bybee, Terry, & Hart-Johnson, 2004).

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Identity in science. Unlike personal identity (perceived needs, standards, and motives which will drive behavior), social identity is perceived when one thinks of themselves as a part of society rather than their unique characteristics (Hogg & Turner, 1987; Oyserman et al., 2017). Bonous-Hammarth (2000) states a similar argument in regards to social identity, affirming that identifying with an academic role, such as a student or a scientist, is much more powerful in predicting academic performance, persistence, and success than identifying with race, economic standing, etc. It highlights the importance of students needing to feel accepted within the academic world, which then leads to a more successful outcome and a productive sense of community (Davidio, Gaertner, Niemann, & Weiss, 2001). In order to feel accepted and a part of a community, particularly a scientific community, students begin to understand what is needed to participate in the community, and recognize those who can help them transition into the scientific community (Brickhouse & Potter, 2001). Students who understand their identity in terms of motivation and self-regulation as part of an academic community can transition to a scientific community. Teachers can establish this type of environment for students, which is crucial for them to understand their place in the scientific community.

Identity as a student. When students view themselves as capable and confident in their ability to accomplish scientific skills, this influences how they view the educational interests and expectations they have for their lives (MacPhee, Farro, & Canetto, 2013). Self-efficacy, the ability to determine and execute a course of action in order to reach a certain goal, is a strong predictor of future academic goals (Bandura, 1997; MacPhee, Farro, & Canetto, 2013). Chemers et al. (2011) share a similar argument and take it further by stating that self-efficacy also predicts commitment to STEM careers. A study done by Chemers et al. (2011) showed that identity helped mediate the relationship between self-efficacy and commitment. Students who understand

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identity as a student in relation to self-efficacy will have a likely chance to commit to a STEM career.

Self-efficacy and identity not only predict commitment to future STEM careers, but also mediate the relationships between science support systems (i.e. research experience, instrumental mentoring, socioemotional mentoring, and community involvement) (Chemers et al., 2011).

Figure 2 displays a model demonstrating the flow of support components and psychological processes to the final outcome, commitment to a science career. The support components consist of experience, mentorship, and involvement within the community. This support from mentors and community partnerships leads to psychological processes such as self-efficacy in science and leadership, as well as forming an identity as a scientist. Ultimately, this leads to the final outcome, which is the commitment to a science career. However, student demographics still play into each component. This flow model is a crucial component to this study since it fits well with (1) the bioscience class through providing experience for students, (2) the larger goals of the project, which is creating an environment to engage and interact with science to understand student interest and motivation, and (3) the cultural aspects of students within the study.

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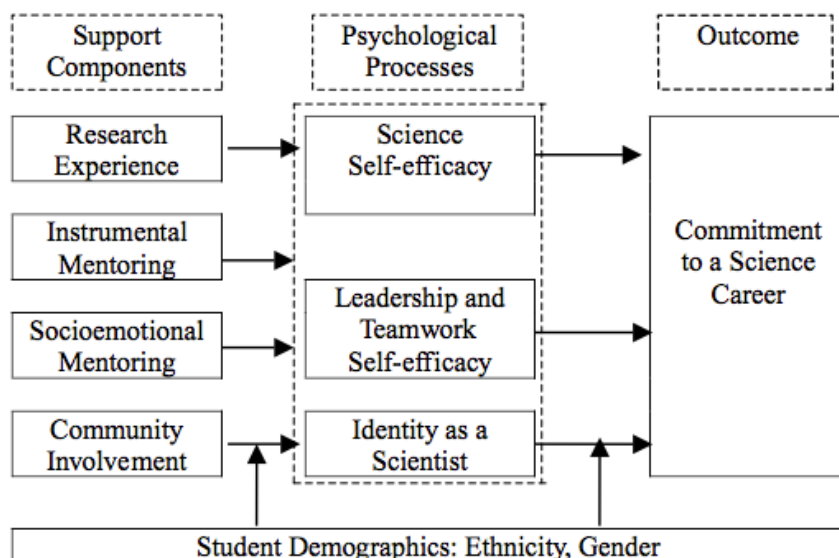


Figure 2. Flow model of commitment to science career outcome. (Chemers et al., 2011)

Underrepresented Students in STEM

Native American, African American, and Latino American students have been underrepresented within the STEM fields, meaning White students are earning the most degrees in STEM (NSF, 2008 tabc-14). While Caucasians make up 62% of the science and engineering degrees, African Americans make up 9%, Latino Americans 12%, and Native Americans less than 1% (NSF, 2014, tab5-6). Having such low percentages of underrepresented individuals begs the question as to why. Lord, Camacho, Layton, Long, Ohland, & Washburn (2009) allude to the lack of persistence in higher education for underrepresented students rather than just lack of persistence in STEM. Students who enter engineering majors are more likely to persist to eight semesters (57%) than non-engineering STEM majors (41%) (Ohland, Sheppard, Lichtenstein, Chachra, & Layton, 2008). Underrepresented students, particularly Native Americans, are much less likely to enter these fields, which creates this lack of diversity in the field.

Native American students. For this research, Native American students were the point of focus since the area research was conducted included a large population of Native Americans.

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Lord et al. (2009) described low persistence in higher education among African American, Latino, and Native American students. There has been evidence of high graduation rates among Native American students, however, a very small percentage actually continues onto higher education after high school (Babco, 2000). Approximately 68% of Native Americans graduate high school, whereas only 23% of high school graduates enroll in college (Stetser, 2014).

Native American women are more likely to enter higher education than Native American men, yet are less likely to choose a STEM related field (Babco, 2000; Lord et al., 2009; Tyson, Borman, & Hanson, 2007). A substantial number of Native American women earn bachelor's degrees, nearly double that of Native American men earning bachelor's degrees (NSF, 2014 tb5-7). NSF (2014) shows that even though women are being awarded twice as many bachelor's degrees, Native American men and women are awarded degrees in STEM equally.

Other underrepresented students. There is a correlation between students entering higher advanced placement classes and the motivation to enter STEM careers (Maltese & Tai, 2010; Sadler, Sonnert, Hazari, & Tai, 2014). Unfortunately, African American and Hispanic students in particular are less likely to enter these classes (Sadler et al., 2014; Tyson, Borman, & Hanson, 2007). The integration of advanced classes causes an increase for students to enter advanced fields (Maltese & Tai, 2010). The complexity of the courses is what matter over the amount of classes taken (Madigan, 1997; Sadler et al., 2014). This lack of diversity and inclusion within advanced high school classes is taking a toll on underrepresented students committing to and persisting in STEM careers.

Bioscience Class Design

In order to carry out a class designed for learning and advancement of knowledge, there needs to be a different pedagogical approach rather than traditional lecture (Wieman, 2007).

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Traditional lecture is not enough to help students (Dierking, 2010; Wieman, 2007). Dierking (2010) describes the issue that traditional roles within the classroom are being shifted, and teachers should be prepared to get students interested and motivated. One shift that is occurring within science classrooms is student-centered classes. McManus, Dunn, & Denig (2003) demonstrated more positive attitudes towards science, and students participating in the student-led classes were able to outperform other students who were taught traditionally. Armbruster, Patel, Johnson, & Weiss (2009) conducted a similar study indicating higher satisfaction towards science as well as increased student performance in student-led classes. When student-centered lessons are created and implemented correctly, there is an evidential increase in student learning and performance.

Programs and classes specifically aimed at underrepresented students can be successful in getting students into a research environment (Kinkead, 2003). Not only did Kinkead (2003) point out the importance of a research environment for students, but also the importance of mentoring relationships and what science careers would actually involve. All of these factors, when combined together, can eventually lead to a greater commitment to STEM fields (Chemers et al., 2011). Increasing underrepresented student's commitment to enter STEM fields can be a positive outcome for both students and STEM fields.

Project-based learning. Another unconventional method of learning is student-centered classrooms called project-based learning (PBL), which allows students to ask questions about topics they are naturally curious about (Bell, 2010). PBL starts off with a driving question, followed by activities to support evidence answering the driving question (Blumenfeld et al., 1991). Through PBL, students are able to bridge connections between phenomena and real life situations (Bell, 2010; Blumenfeld et al., 1991). Many students do not view scientists or science

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as even remotely relevant to their personal lives, and therefore need intentional opportunities to view science as relevant (Palmer, 1997). Being able to connect these can deepen learning and allow students the opportunity to view themselves as scientists.

Investigating issues about topics that intrigue students through PBL sparks interest in student learning as well as makes the material relevant to the student (Blumenfeld et al., 1991; Christensen & Knezek, 2015). Teachers initially create a learning environment allowing for this type of learning (Krajcik & Blumenfeld, 2006). When the appropriate learning environment is created for a PBL class, Krajcik & Blumenfeld (2006) describe five key features to the class:

1. A driving question is asked in order for a problem to be solved;
2. Inquiry takes place in order for students to obtain an authentic experience of answering the driving question. This experience will then be applied to the topic at hand;
3. Solutions to each driving question will be explored by students, teachers, and community members in order to problem solve;
4. Teachers scaffold activities for students to partake in, even if the activity is beyond the student's ability; and
5. Tangible evidence will be shown to the students for visual representations of student thinking.

As each of these key features are employed within science classrooms, students will gain a stronger understanding of problem-solving, community building, and learning skills.

Community partnerships. Partnerships between students and the community are an important part of student identity within the scientific community, allowing students to interact with scientists, peers, and professionals within STEM fields (Chemers et al., 2011). Gandara and Maxwell-Jolly (1999) describe this as being essential: developing a sense of place as scientists.

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Students need to form friendship networks in order to have a comfortable social climate (Hurtado, 1994). Tinto (1987) validated that minority students need outside classroom activities to be incorporated within school in order to successfully persist.

Bouillion and Gomez (2001) demonstrate that community partnerships bridge the gap by “(a) making visible multiple science identities, (b) tapping and bringing together distributed funds of knowledge, (c) supporting an active network of exchange.” (pg. 894). Community partnerships allow students to identify with science in such a broad sense helping them find a place in this world as they are being scaffolded into community (Lave & Wenger, 1991).

Conclusion

Identity and self-efficacy play a major role within motivation to enter a STEM career. Understanding these key players can expand opportunities for educators and students alike (Chemers et al., 2011; MacPhee, Farro, & Canetto, 2013). Through understanding identity and self-efficacy, project-based learning, and fostering community partnerships between students and community members, there can be a class offered to underrepresented students in order to bridge the gap between real-life problems and the sciences. There is still a continuing challenge to nurture relationships between students and persistence in STEM fields (Bonous-Hammarth, 2001; Davidio et al., 2001). Further studies into this relationship should be explored more for concrete and concise answers.

The overall goal of this research was to utilize studies in order to observe and analyze underrepresented students in a PBL bioscience class. Students attending this class were surveyed and interviewed throughout a school year to determine self-efficacy, identity of self as student and scientist, interests, and career goals. The need for underrepresented students in STEM

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careers is blatant. Students need opportunities to engage and experience science in real-life as well as develop a sense of self in order to feel satisfaction in entering a STEM field.

Methods

The purpose of this study is to examine and compare two high school students' developing scientific identity over the course of their participation in an afterschool bioscience program, and to examine the extent to which a project-based learning bioscience course increases these students' interest in STEM careers. This project is part of a larger project, Innovation Collaborative Research Experience and Technical Education (iCREATE) that examines how a project-based bioscience course, designed with input from community and industry partners, affects students' self-efficacy, interest, and motivation toward STEM careers. Pilot study data indicates that a students' STEM career interest increased over time. This study closely examined two students from different cultural and ethnic backgrounds in an effort to learn how their sense of place within the scientific community influences STEM success.

For this research, I conducted an exploratory sequential qualitative case study (Creswell, 2014). Case studies are a detailed method of understanding and explaining phenomenon within the real world (Yin, 2014). Identifying a phenomenon and being able to clearly relate it to the real world cultivates understanding of phenomena and demonstrates the relationship between the two. Case studies are considered qualitative research, meaning questions are asked pertaining to certain individuals in order to clearly recognize patterns through procedural steps to be interpreted by the researcher (Figure 3). This study is exploratory and sequential because qualitative data was collected first, which can transition into a quantitative study in further research of the material. A case study research design allows qualitative data to be collected,

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which is expected to yield comprehensive results demonstrating development of self-efficacy, interest, and motivation to enter STEM careers, adding further to the literature.

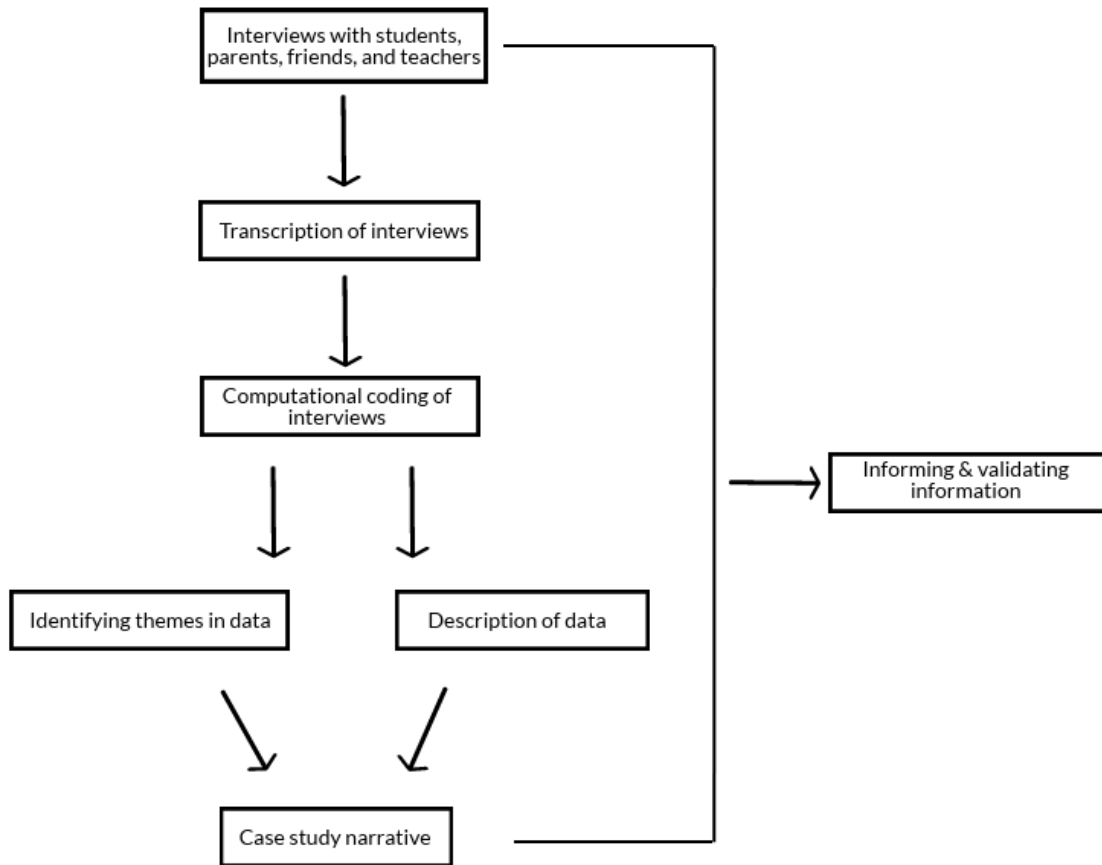


Figure 3. Analysis of the qualitative case study used. Adapted from “Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (4th edition)” (p. 197), by J. W. Creswell, 2014, Thousand Oaks, CA: Sage Publications.

Qualitative data collected for this research addressed the research question, (1) To what extent did the scientific identity of two high school students participating in afterschool bioscience course develop over a school year? (1a) What were the differences in scientific identity development between an underrepresented minority student and a Caucasian student?

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(1b) In what ways did the students' self-efficacy, interest, and motivation to enter a STEM career evolve?

Context

Recall that this study is a part of a larger project where students participated in a student-led classroom where they partnered with the community to solve a common problem. This project gave local high school students the opportunity to personally and academically engage with aspects of science and technology. As provided through Coconino Association for Vocations, Industry and Technology (CAVIAT), a school district that provides career and technical education to the local county, the bioscience class addressed a local problem in the community, tracking of influenza-like illnesses (ILIs). Partnering with local organizations such as the Center for Science Teaching and Learning at Northern Arizona University, Translational Genomics Research Institute North (TGen-North), Flagstaff STEM city, county epidemiologists, and local healthcare providers, researchers designed iCREATE to not only solve a community problem through community partnerships, but also ensure a quality science and technology education to expose high school students, particularly students in underrepresented groups, to a variety of STEM field opportunities.

Students from local high schools came to the university to participate in this class four days a week after school for three hours per day. Students worked with and learned from scientists, creating solutions to problems through research and community activism. Through the development of bioscience skills and techniques, students who completed this bioscience class were able to address scientific problems confidently and innovatively. Through this experience, students' awareness of STEM fields grew substantially, while increasing student motivation to pursue a STEM career.

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Participant Selection

Student Participation. Since the research focused on the underrepresented students within the class, I used specific criteria when screening cases, or students (Yin, 2014). Students within the iCREATE bioscience class were selected based on ethnicity, grade level, prior involvement in STEM, career goals, and home life. I took a one-phase approach during the screening since there were only 12 students enrolled in the bioscience class (Yin, 2014). Because I had such specific criteria in order to complete this research, I observed the class for a few days to understand the students and discern which students would be appropriate research subjects. In addition to observing the class, all students were given three instruments to determine interest, motivation, and attitude towards STEM careers for iCREATE. The three instruments used were Career Interest Questionnaire (CIQ), STEM Semantics Survey (SSS) (Tyler-Wood, Knezek, & Christensen, 2010), and Science Attitude and Motivation Survey (SAM) (Ngari, Despriet, & Monsaas, 2008).

Based on the results of the instruments and my observation, I determined which students fit the research criteria best. The selection of students was mostly based off a sample of convenience. I wanted to intentionally select students from different races in order to understand the differences, if any. Each student met my criteria of different races, similar age, differing STEM backgrounds and careers, similar interest in STEM, and different family STEM involvement. I selected two high school students from different local high schools, one junior of Native American descent and one senior of Caucasian decent (Table 1). I chose a Native American student since the majority of the class was Native American and Caucasian. The few other underrepresented students in the class were not chosen due to convenience and availability. I initially selected two male students who fit the criteria well, but unfortunately one of them

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dropped the course due to schedule conflicts. The other student remained in the course and consented to being a participant. Subsequently, I screened all the students a second time and selected another student fitting the criteria. My selection of students included one Caucasian male student and one Native American male student.

The male Caucasian student, given the pseudonym Connor Patterson, came from a two-parent household who were both heavily involved in STEM careers. Conner was involved in advanced classes at a local public high school and indicated a career path in a STEM field. Milan Harris, the male Native American student, came from a two-parent household where one parent was involved in a STEM fields whereas the other parent was not, was involved in advanced classes at a local public high school, and desired a career involving STEM. I included one Caucasian student and one Native American student in order to understand how cultural background impacted STEM success. The selected students fit all the criteria well. Once students were selected, I talked with both students as a group about the research and gave them assent forms to complete. Since each student was a minor, parental permission was required. Students took permission forms home to their parents, which were later, returned.

Table 1

Student Demographics.

Student	Grade	GPA	Ethnicity	Age	Gender	Home Life
Connor Patterson	12	3.4	Caucasian	18	Male	2 Parents
Milan Harris	11	3.0	Native American	17	Male	2 Parents

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Parent Participation. In addition to student interviews, I interviewed parents or guardians to understand student interest and involvement at home. Prior to interviews, parents were given a consent form. In order for the student to participate in the research, an interview from the parents was required. Table 2 displays parent demographics. Parents did not need screening from me.

Table 2

Parent Demographics

Parent	Job	Education	Ethnicity	Gender
Mrs. Patterson	Dental Hygienist	Bachelor's	Caucasian	Female
Mr. Harris	Anesthesia Tech	12th Grade	Native American	Male

Friend Participation. Students selected for this research needed to recruit a friend for an interview given by the researchers. Assent forms given to friends needed to be signed in order to participate, and a parental permission form was also given to the friend's parent since all friends were minors. Friends needed no screening in order to be interviewed. Criteria given to students when choosing a friend was that the friend needed to know the student well enough to complete an interview regarding that student's interests, career choices, and personality. Both students chose friends from the bioscience class. The sample of friends taken from the bioscience class made the interviewing process simpler, but did not diminish the information I collected. I believe this contributed to the research since I already established rapport with the students through previous interviews, and students felt more comfortable with the interviewing process.

Teacher Participation. At the start of the research, I planned to include a teacher from

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the bioscience class as well as a teacher from the student's own high school, in order to examine the differences between student development in a normal high school class and development in the bioscience class. Students chose which teacher they preferred me to interview, so screening was not required. When I contacted the teachers at the students' high schools, the teachers either politely declined my request due to availability, or did not respond to my emails. However, I was able to interview the bioscience instructors, where I hoped to gain a better understanding of student development and interest to enter STEM fields as a direct result of the bioscience class. Teachers in the bioscience class were experienced teachers, one with experience teaching middle school and the other at the collegiate level. Both teachers taught the course the previous year. The class instructors spent a substantial amount of time with students, more than individual subject teachers at high school had interacted with students. Bioscience teachers did not need screening, since they were a part of the iCREATE project.

Data Collection

Through the iCREATE project, students took three pre-assessment instruments: CIQ (Appendix C), STEM Semantics (Appendix D), and SAM (Appendix B), at the beginning of the school year demonstrating attitudes, interests, and perspective on STEM and STEM careers (Figure 4). Approximately a month and a half before the bioscience class concluded, students took these three instruments for a second time as a post-assessment. These instruments were used to select students and guide the narrative of the study.

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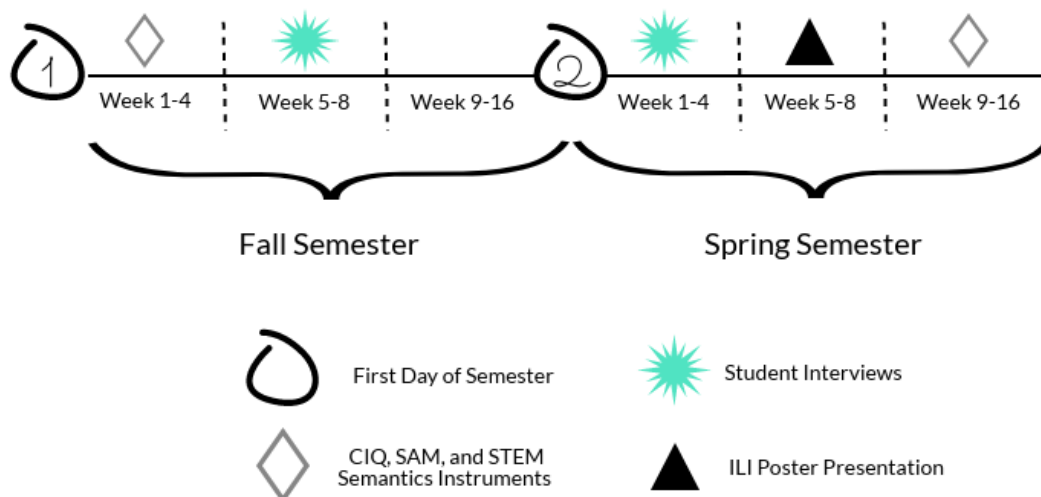


Figure 4. Timeline of data collection.

Student Interviews. Selected students were asked to participate in my research, which required semi-structured interviews to be given. Students who consented to the research were interviewed individually in person by the researcher. The first interview occurred during the first semester of the school year, before students were familiar with the bioscience class. A second interview was conducted during the second semester of the school year once students were finished with their main project, and were about to present their findings. Adapted from Blustein et al. (2013), the interview protocol explored student career goals, future plans, impact of student identity, and STEM experiences (Appendix E). Interview questions aimed to understand the students' thinking toward STEM careers, interest in STEM, and impact of family, school, and identity. Each interview lasted 20-30 minutes. All student interviews were audio recorded, transcribed, and coded based on a coding system adapted from Blustein et al. (2013). Main codes were identified then given subcodes to specify quotes. Interview responses were coded with the main code and subcode most appropriately correlated with the response (Appendix A).

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Parent Interviews. Students recruited a parent to participate in a semi-structured interview given by the researchers. The selected parent consented to the interview, and all interviews given occurred over the phone. Each interview was 10-15 minutes long (Appendix F). Questions within the interview protocol examined student interest, hobbies, and parent involvement. Parent interviews were audio recorded and transcribed.

Friend Interviews. Friends, recruited by students, took part in a semi-structured interview, with consent from both the friend as well as the friend's parent. Interviews with friends either occurred during the bioscience class, since most students selected friends in the bioscience class, or interviewed over the phone. Bias by interviewing friends already in the bioscience class did not occur, but having already interviewed student previously for iCREATE data created an environment of comfort, which added to the information given. Interview protocol included questions exploring level of friendship with student, student interest, and development of career choice since meeting. Interviews lasted 10-15 minutes long (Appendix G). Friend interviews were audio recorded and transcribed.

Teacher Interviews. Though this research was to include two teacher interviews, one teacher was interviewed through a semi-structured interview protocol. This protocol included questions examining student skills in class, willingness to volunteer, and development of student interest throughout the class. Interviews lasted 10-15 minutes long (Appendix H). Teacher interviews were audio recorded and transcribed.

Data Analysis

Qualitative data analysis. All three instruments were taken consecutively, and once completed, entered into an Excel spreadsheet. I observed instruments individually, gauging student answers and noting which students would fit the criteria well. These instruments were

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also used to guide the narrative in the findings of this research.

Six main codes were identified within the interviews that were used and adapted after interviews were completed. The codes include: Educational and Career Planning, Identifying Connections to Future Work/Goals, STEM experiences, Bioscience Course Experiences, , Impact of Student Identify, and Perceptions of Self as Student (Table 3). Each main code had a subcode to specify certain similar responses from students.

Table 3

Codes Used for Student Interviews

Main Codes	Subcodes
Educational and Career Planning	Current educational experience Perception of school or school value Educational aspirations Career aspirations Non-STEM exploration STEM exploration Lack of exploration Positive future outcomes* Negative future outcomes*
Identifying Connections to Future Work/Goals	School and work/goals Personal interests and work/goal
STEM Experiences	Attitudes toward STEM courses and careers Personal experiences* Family experiences* Peer experiences*
Bioscience Course Experiences	Positive bioscience course reactions* Negative bioscience course reactions* Neutral bioscience course reactions Impact of Bioscience course Increase in competence/knowledge in STEM topics Increase in motivation to explore STEM careers and topics

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Impact of Student's Identity

- Ethnicity
 - Impact of ethnicity on career
 - Impact of ethnicity on school experiences
 - Active involvement or sustenance due to ethnicity
- Race
 - Impact of race on career
 - Impact of race on school experiences
 - Active involvement or sustenance due to race
- Gender
 - Impact of gender on career
- Resources
 - Family resources
 - Peer resources
 - Educational resources
 - Community/societal resources
 - Barriers/unsupportive influences
 - Barriers/unsupportive influences from self
 - Barriers/unsupportive influences from family
 - Barriers/unsupportive influences from peers
 - Educational barriers/unsupportive influences
 - Barriers/unsupportive influences from the community/society
 - Logistical barriers/unsupportive influences
- Religion

Perceptions of Self as Student

- Self as student
- Self-confidence
- Self-knowledge

*Subcodes either added or revised

All main codes, adapted from Blustein et al. (2013), were discussed thoroughly by each student in all interviews conducted. Most evidence collected to analyze student identity and motivation were from student interviews. "Educational and Career Planning" was the first main code identified within the interviews in order to establish data demonstrating evidence of future plans in both educational aspirations and career goals. Since this was a large category, subcodes were needed to identify specific responses and were adapted from Blustein et al. (2013).

Interviews were conducted to obtain the data within this category and all three students discussed

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this theme extensively in both interviews. Subcode usage varied depending on student answers. Two subcodes were added to the main code for clarification purposes. “Positive future outcomes” and “Negative future outcomes” were more precise to student responses.

The second main code identified, “Identifying Connections to Future Work/Goals,” was used to collect evidence to see if students distinguish a connection between their life currently and their life in the future. Subcodes were used to differentiate evidence between understanding in personal life and understanding in school. Students were able to identify this connection at least once in all interviews.

The main code “STEM Experiences” was used to indicate what types of personal, peer, or family experiences each student had faced, and general attitudes about STEM. All students gave in-depth explanations of personal experiences, as well as a few family and peer experiences in both interviews. For clarification, subcodes “Personal experiences,” “Family Experiences,” and “Peer Experiences” were reworded.

In the second interviews, the main code “Bioscience Course Reactions” was used to indicate how students responded to different components within the bioscience class. I collected this data during the second interview once they were more experienced within the class and better able to understand their reactions to the class. Connor was able to clarify this in his first interview, however, the majority of evidence stemmed from the second interview. Subcodes were utilized, and “Positive bioscience reactions” and “Negative bioscience reactions” were reworded for clarification.

The most influential aspect of a student’s life is his or her identity, therefore, “Impact of Student’s Identity” was utilized to obtain evidence regarding a student’s cultural, racial and ethnic background, gender, barriers or unsupportive influences, and other factors contributing to

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overall self-identity. All students thoroughly and extensively discussed this main code, along with several common subcodes, in both interviews given.

The final main code described the student's own view of self in regards to who they were as a student in "Perceptions of Self as Student." Students were encouraged to reflect on who they were as students and all responded in both interviews given. Subcodes used to specify evidence included confidence, knowledge, and general self as student.

Parent, friend, and teacher interviews were transcribed and analyzed using common student interview themes. This includes "Educational and Career Planning" indicating the participant mentioned future education or career aspirations of the student. Demonstrating evidence of attitude toward the bioscience class will use the theme "Bioscience Course Reactions." Another theme specifying a student's identity, whether race, ethnicity, culture, gender, barriers or unsupportive influences, responses will be indicated in "Impact of Student's Identity." Parent, friend, and teacher quotes were utilized to support common themes students discussed within their interviews.

This coding system was used in order to identify main themes within the student interviews only. All segments of interviews pertaining to these main codes and subcodes were used within the research for analysis and interpretation. Parent, friend, and teacher interviews were analyzed for quotes to support common themes and used to guide narrative of study.

Summary

Using an exploratory, sequential case study in this qualitative research, I examined student identity, interest, and motivation to enter a STEM field, particularly with respect to underrepresented students. Sources of data included three instruments: CIQ, SAM, and STEM Semantics survey to gauge student interest, attitudes, and motivation regarding STEM careers.

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Semi-structured interviews were conducted, once during the first semester of student participation in the bioscience class, and a second time during the second semester of the bioscience class. The CIQ, SAM, and STEM Semantics Instruments were used to select students for the research and assist narrative. Student interviews were audio recorded, transcribed, and coded based off main codes and subcodes adapted from Blustein et al. (2013).

Findings

In the following section, I present findings in congruence with my research questions and the question of underrepresented student interest and motivation to enter STEM careers. The identified themes of Educational and Career Planning, Identifying Connections to Future Work/Goals, STEM Experiences, Bioscience Course Reactions, Impact of Student Identity, and Perspective of Self as Student (Appendix A) will be presented in the findings of each student. Each section will deal with one student and their response to each theme, creating a narrative.

Connor Patterson

Connor was a senior at a local high school and planned to graduate the coming May. He identified as Caucasian with no strong ties to his cultural background. Connor's parents were both involved in STEM for over 17 years, his mom as a dental hygienist and his dad as a nurse. His career goal prior to entering the bioscience class was to become an ophthalmologist or an optometrist since he felt a strong passion for eye care. I selected him in my sample based off his interest in the bioscience class as well as his instrument responses, Career Interest Questionnaire (CIQ), Science Attitudes and Motivation (SAM), and STEM Semantics.

Educational and Career Planning. When asked if he would be interested in and would enjoy a STEM career, Connor indicated a strong interest when answering the pre-assessment CIQ instrument given at the beginning of the school year. Connor detailed his interest in

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Interview 1. He noted that since his family is involved with STEM careers, and having a mother involved in dentistry, he was also interested in dentistry. Connor also mentioned his interest in ophthalmology or optometry. He discussed his dream to be an ophthalmologist or an optometrist and how he enjoyed the technical side of eye care. Connor connected this technical career with his personality and personal interest. On his post-assessment CIQ instrument, when asked if he would like to have a career in science, Connor responded he agreed with the statement, whereas prior he strongly agreed. During Interview 2, Connor displayed a much narrower path in regards to what he wanted to do and how he was going to achieve his goals. He talked mostly about the educational route he planned on taking, and the type of degree he thought would benefit him the most.

Interviewer: Do you have some ideas of what you'd like to do after you graduate from high school?

Connor – *Interview 1:* Yeah I definitely want to go down the medical field just kind of like past family stuff. My mom is in the dentistry stuff so that really interests me, and I'm also looking into optometry or ophthalmology or something like that . . . I wanted to do something with technology and surgery or like biomedical engineering and stuff like that. I didn't want to do just like huge open wound surgeries and stuff cause that kinda grosses me out and we found like optometry and it's super small. Like under a microscope and really technical and I'm super technical with my hands because of oboe playing so like I think that fit my personality well.

Interviewer: What are your career goals at this point?

Connor – *Interview 2:* I've done some more research about scholarship opportunities and how I'm going to get through that part of college. Right now I'm thinking my best chance

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would be, because my end goal is to go to medical school, so whether that is through community college then university or just maybe getting a scholarship that goes right through. I've been researching that. I'm thinking about a music degree, which I know we talked about last time. I know you said that they [have a] really big percentage of music kids, because I guess it just shows like well-roundedness and commitment so I think, and I think I would have a bunch of opportunities in that . . .

At the beginning of the school year, Connor showed an interest in a variety of STEM career paths. He discussed with counselors, teachers, friends, and his parents about what he should do, and what would best fit his personality. Over the course of the bioscience class, he seemed to have focused mostly on ophthalmology or optometry, even looked at scholarships and majors that opened doors to better opportunities. Connor's friend, Miranda Wright, corroborated this finding; stating that Connor's interests narrowed the longer they were in the bioscience class. She was not specific as to what career in which he was interested, but she mentioned Connor received an extensive education allowing him to have a diverse background, which may have helped when he entered college. Miranda stated Connor had little sense of direction when they met four and a half years prior at school. She spent time with him as they both completed projects and classes, and mentioned how they both grew in their own ways. Miranda said she could always see Connor in a science field. With Connor's interests in science and his developed sense of scientific identity, it seemed like the science route was a field he was specifically bound to take.

Interviewer: What other ways has this class affected his way of looking at science?

Miranda: I think it's helped push him to what he wants to do. Kind of getting the other side of science because we've always, like normally, we've been doing chemistry or

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physics for four years so opening up a different kind of view at times has helped add a broader based background for college

Interviewer: From the time you have known your friend, how have you seen him/her grow in interest for STEM careers?

Miranda: Um, I think definitely when we were younger we didn't really have a direction of what we wanted to do. At least I didn't see the direction of what he wanted to do. Then over the years we've kinda grown in our own ways. We've done projects by ourselves, we've kinda learned what we want to do so I've seen him grow independently and specifically what he wants to do. But I think he's always been science. I could always see science.

Connor's mother, Mrs. Patterson, confirmed this interest in STEM fields when asked about their conversations regarding his future plans. Mrs. Patterson's interest and knowledge of Connor's future career plans was evident. She detailed the difference between ophthalmology and optometry, which were the two fields Connor was interested in pursuing. Mrs. Patterson speculated as to why he is interested in eye care due to his own personal experience, and confirms his deep interest in this STEM field.

Interviewer: How does Connor talk about future plans with you?

Mrs. Patterson: Well he is talking about ophthalmology, which is, um, or optometry. Optometry is the doctors that actually do eye exams and diagnose and find different things and then they send them to the ophthalmologist which I think is the doctor that does the surgeries on the eye like Lasik you know any sort of retinal problem so all that kind of stuff . . . his interest and probably because he's worn glasses from a very young age and you know now contacts and it just interests him.

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Concerned about family pressure being a factor in choosing a STEM career, I reflected on his instruments once more. In the pre-assessment CIQ instrument, Connor responded to the statement his family encourages him to study science. Connor indicated he disagreed with the statement. In Interview 1, he stated does not feel pressure from his family to enter a STEM career. Connor, in Interview 1, answered the question about what sorts of conversations he had about his future career plans with his family. He responded that his parents were heavily involved in STEM, and it is a common topic for them to discuss. He continued on about how they expect him to go into STEM as well, yet they are not an influential factor in his decision. I inquired more on the issue of pressure from his parents and asked if he had any family members currently in college, particularly siblings. Connor stated his two older brothers had indeed gone through college and chose careers non-STEM related. Interestingly in the post-assessment CIQ instrument, Connor strongly agreed with the statement his family encouraged him to study science as opposed to his pre-assessment CIQ instrument response. Interview 2 indicated a shift in conversation with Connor's parents. The bioscience class, as mentioned by his friend Miranda, narrowed his focus of career choices. Once Connor decided exactly what career he wanted to enter, his conversations with his parents shifted from choosing a career to discussions involving the different aspects within the job he chose.

Interviewer: What sort of conversations do you have with your parents or guardians about your future education and career plans?

Connor – Interview 1: They kind of expect that, that I'm just going to go [into a STEM career] but I don't think they have an influence in what I choose. I think they will be supportive of whatever I choose.

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Interviewer: Are any of your family members currently in or was in the past enrolled in college? Where were they enrolled? What did they study?

Connor – Interview 1: I have two older brothers in college, both my parents and all my siblings have all graduated from college. One of them is a police officer in [the local city] so he just has his associates or something. Then my oldest brother he is a graphic designer. So he got his bachelor's also. Neither one is STEM related.

Interviewer: How do parents/guardians help you think about future careers?

Connor – Interview 2: They talk to me about like the I guess harder aspects of that job and what day to day life would be with that job. They would help me grasp whatever I would end up doing or telling me what I might be good at or something like that.

Mrs. Patterson agreed with this statement, in her own words, when I asked her if she felt herself pushing Connor to enter the STEM fields because she and her husband were also a part of STEM. Mrs. Patterson stated she did not think she pushes him into STEM. It surprised Mrs. Patterson when Connor did not go into engineering, but science instead. She made it evident she wants him to be happy and successful, regardless of what career he goes into.

Interviewer: Do you find yourself pushing your child more towards a STEM career?

Mrs. Patterson: Um no I don't think so. You know he was in [a technology program at high school] he graduated as a junior with that being a three-year program and that's a really heavy science but also a lot of computer, engineering stuff and, um, he took those and really didn't have much of an interest in that which I was kind of surprised. I thought maybe he would go kind of down the engineering road. But no, I want him to be happy, you know, and obviously like I said a career he can get a job in, and be successful not just financially, but also successful on a personal level. Something [that is] meaningful.

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Identifying Connections to Future Work/Goals. Though Connor elaborated little on this section, I identified his understanding of the connection between what he does now and his future. When asked in the pre-assessment SAM instrument, Connor strongly agreed with the statement, “doing well in science is important for my future.” Being very much aware of the implications medical school required in Interview 1, Connor knew that the mindset he has now determines his path for the future. He acknowledged his mindset might change over the course of college, which he seems open to evolve. Connor indicated the same response in the post-assessment SAM instrument when posed with the statement, “doing well in science is important for my future.” During Interview 2, when asked about the connection between his life now and his future, Connor remarked the amount of work he would be putting into school because it is what he needs for his career in the future. Connor showed an understanding of the difficulty and demand school will require of him. He seemed prepared, relating it to the number of school years he has already been through. Connor also thought about the knowledge he will gain which will be crucial in the future.

Interviewer: What is the connection, if any, between how you are as a student now and your life in the future?

Connor - Interview 1: Um, I know the amount of schooling, since it's medical school and undergrad and residency, so it's like imagining all the school years I have down now and doing that all over again which seems very intense so who knows where I will be or what mindset I will have.

Connor - Interview 2: I think that I'm going to put a lot more work into just my college career because I know it's information that I'm actually going to use in the future unlike a lot of my high school stuff.

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STEM Experiences. Connor was involved with STEM since middle school, and actively involved in STEM throughout high school. He attended a specific program that targeted advanced STEM classes in middle school. He reflected on advanced math, engineering and science levels in particular where he felt ahead of students who did not partake in the program. Connor noted the differences between his program and other classes in his grade where his class was more interactive whereas the other classes taught straight out of the textbook. He stated how the program he was in pushed him in these subjects, and suggested if he had not been a part of that program he would not have learned as much.

Interviewer: What has your experience been in school with courses/classes in science, technology, engineering and math (STEM)?

Connor: So I went into my, like I said, middle school which is a thing offered at (local MS) and it is Middle Institute of Technology and Engineering (MIT-E) so, yeah, perfect for that. It's just like advanced years so like we were always a year or two above other students, um, just with math levels, and we had the separate engineering, and science was above everyone else too. I really lucked out because it was very hands on compared to other classes which was just strictly out of the book. We didn't necessarily have, uh, like a strict course outline, I guess, so it was really just kinda, uh, you know we were still pushed to do stuff but they came with their own activities and stuff. So, uh, I think I learned a lot more in that then I would to just have a book in a regular science class

Interviewer: So you had a pretty positive experience then?

Connor: oh yeah, for sure.

Connor was adamant his experience in middle school was a positive one and lead to even bigger opportunities for him. Connor continued, explaining the transition into the program he

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completed at his high school. He discussed how engineering was an important component of the program and how it impacted him. Connor expanded on his responsibilities for the program like how he had to complete a capstone project, which kept him responsible and taught him how to set goals. He connected this experience with his life and how he can implement these skills in any area. STEM was a driving force throughout his education, and Connor continued describing his high school experience, which his middle school experience led into.

Connor: Then that led to CIT, which is Coconino Institute of Technology and that, was huge. We had to, you know, it really got my engineering, [I got a lot] out of it. We had to come up with a capstone, for like a full year and work on that and have to goals set. Like I think, like, I can implement that in any part of my life you know with just time setting and stuff like that.

Interviewer: So you have had a really extensive experience in STEM.

Connor: Yeah!

Interviewer: Are you taking any science classes now?

Connor: Yes, AP Chemistry and I love that class

Bioscience Course Reactions. Connor attended the bioscience class offered through CAVIAT from the beginning of the school year to the following May. He reflected on the class at the time of Interview 2, stating the diversity within different science fields. Connor indicated without the bioscience class, he would not have been introduced to a variety of STEM fields.

Interviewer: What have you liked about the bioscience class?

Connor: Yeah so I think a big part of it was, um, just getting introduced to all the different people from all the different fields like the librarian came up from [local community college]. Like, going to the pathology lab and like, um, just [being]

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introduced to a lot of different science that I wouldn't necessarily have seen outside of class or outside of this college class so that was really cool. Um, and other than that just kind of hands on team building stuff that I've always been a really big part of that so that's cool.

Connor previously studied some of the material in the bioscience class earlier in his educational career. He did mention a couple labs he has not previously performed, which he found interesting. Connor was interested how his main project worked closely with a subject area he had little involvement with, and how it tied in with the community.

Interviewer: What is particularly interesting to you about the class?

Connor: Um, that's a hard one because a lot of it, a lot of it has been stuff that I've done kind of previous in other courses in science classes but kind of re-learning it because some of it I haven't done since middle school, 8th grade. I think it's a proper [way of doing labs] before going into, like, a science major so, um, we just did staining for bacteria and stuff, and that was super cool. I've never done anything like that. Um, and just the research paper, and the amount of work we go into about epidemiology and how it all like connects into the community and stuff is really cool.

Since Connor had such an extensive background in STEM, he showed a lower interest in the class when discussing how he has already learned this material during the interview.

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However, when asked what the most satisfying accomplishment was, he concluded his motivation in completing the class. Connor also noted his ability to not allow peers who dropped the class earlier in the school year to sway his motivation and interest in completing the class. He praised the instructors in keeping the workload outside of class low, since he assumed they knew everyone had work to do for high school. He reflected on how the class would aide his future educational goals.

Interviewer: What is the most satisfying accomplishment for you in taking this class?

Connor: Um, I think just starting it and finishing it. It's just so much. It's four times a week, three hours a day. They're really good about not having us take too much work home with us because they already understand we have so much work already from regular high school but I think just pushing through it. Kind of, not letting what others do like drop out in the middle of the semester influence my accomplishments and stuff and I think it will pay off in the future with like required credits in college.

Impact of Student Identity. Student identity was a large theme discussed during student interviews. For this research, cultural background, gender, educational resources, barriers/unsupportive influences, and religion are examined below.

Cultural background. Cultural background is an important aspect for most students; however, Connor indicated his family was not as involved with cultural background. He stated his family was American, with relatives who were French Canadian and German. He reflected on this information, and concluded this cultural background had no influence on his life or future.

Interviewer: Please tell us about your cultural, ethnic, and racial background. How do you identify yourself in terms of race and ethnicity?

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Connor: So my family is not too big on past stuff, we are American obviously but we don't do hardcore research on where we are from. Like we are here now, so how can we help the world I guess. But I do know some of my background, my grandma was French Canadian and I have family from Germany so those are my two big ones. Those don't rule into my life in any way shape or form.

Gender. Connor reflected on how gender influenced his family's expectations of his future because he is a male, and determined since he had two older brothers, there was no comparison as to how he would be treated differently in his family. He stated his family is supportive, and regardless of gender they would want the best for him, as long as it aligns with his values.

Interviewer: How do you think your family's expectations about your future plans are shaped by the fact that you are a woman/man?

Connor: Well I only have two older brothers, so I really haven't been able to see that approach differently let's say if I had a sister. So I can't really compare it to anything. Um, but you know I see them as supportive and just kind of do whatever you want, I guess, just as long as it's in your morals or stuff like that.

In the pre-assessment SAM instrument, Connor felt strongly about the roles of men and women in science. He strongly disagreed with the statements, "males are naturally better than females in science" and, "I would have more faith in a science problem solved by a man than a woman." Connor strongly agreed with the statement, "studying science is just as necessary for women as it is for men." He indicated the same answers to the exact questions when he completed the post-assessment SAM instrument.

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During Interview 1, Connor denoted the female dominance within optometry, which is the career he wants to enter. He compares this with dentistry, which is more male dominant. He stated his comfort in entering a female dominated field. He explained he did not care about the influence of genders. In Interview 2, Connor mentioned once more the high percentage of females in optometry. He observed how interesting the statistics were, and he had no reservations entering a female dominated field. Interestingly, he mentioned since it was female dominated might deter people to enter the field.

Interviewer: How do you think your gender influences your interests and what you believe you can do in the future?

Connor – Interview 1: Um, I think optometry is more led by females. It's not too big, it's like a 73% [female] dominance. So which I am definitely more interested in optometry than dentistry which dentistry is more male occupied. So I don't really think I will have a problem going into a female dominated field. I'm pretty mixed with genders, so I don't really care.

Connor – Interview 2: Just like last time, we talked about how high healthcare is more female dominant, which is kind of interesting. So me going in as a male, like, I don't think it will have an effect on anything, but it could persuade other people not wanting to go into it so.

Educational resources. Connor identified a variation of educational resources he had encountered, and saw a variety of ways to hear about STEM careers through the bioscience class. When asked what he had learned from his high school teachers during Interview 1, aside from the bioscience instructors, Connor stated his teachers told his class STEM careers are fulfilling and can create opportunities otherwise unlikely to create.

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Interviewer: What have you learned from your high school teachers (not the bioscience class) about STEM courses and fields?

Connor: I guess all of them have the pattern of repeating that it's very beneficial and rewarding because you know you have the chance to experience what no one else has so, um, yea no they all really like it. Just rewarding with what you learn.

During Interview 1, Connor elaborated on his relationship with his teachers and counselors when it came to talking about future career paths. He stated his counselor was very valuable when searching for a career path he could enter. His counselor talked through different fields, identifying which would fit his interests and personality the best. Connor's counselor helped him think about STEM fields he was interested in, and commented on how his teachers never did anything similar, though he did feel like he could approach his teachers if he had questions about STEM fields. Connor agreed with the statement, "my teachers encourage me to take as many courses as I can in science" in his pre-assessment SAM instrument, however, indicated in his post-assessment SAM instrument he strongly agreed with the statement.

Interviewer: Also, what have you learned from your counselors about STEM courses and fields?

Connor: Yeah I had a counselor my first three years of high school. She was really helpful and we kinda just went through pretty much every science career and talked about it and how you know it would relate to me. I kinda just went to her and [said] how I wanted to do something with technology and surgery or like biomedical engineering and stuff like that. Teachers I don't really have that connection with.

Interviewer: So do you feel like you could approach your teachers and talk about that?

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Connor: Oh for sure, I guess it depends on the teacher really. I mean I've come to some like I could definitely talk to the [bioscience] teachers here about that.

Though Connor mentioned in Interview 1 not having a connection with his teachers, he did realize the importance of having supportive teachers. In the pre-assessment SAM instrument, Connor strongly agreed with the statement, “My teachers encourage me to do well in science.” He maintained this sentiment in his post-assessment SAM instrument as well. He recognized the importance of motivation, along with educational resources apart from the teacher. He mentioned his chemistry teacher was a supportive resource because of the study groups assigned to them. Interview 2, Connor recognized once more how important it was to have approachable teachers. He also mentioned hands on curriculum was helpful, but reaffirmed how teachers were valuable to his learning.

Interviewer: What do you think helps you the most to do well in school?

Connor – Interview 1: Um, I think it all comes down to me and my motivation, um, because even if the teacher is not that good I still have resources online and stuff to learn. Support I guess, teachers who like get groups like study groups. My chemistry teacher is really good about that. We do study groups every week, which is good.

Connor – Interview 2: Having a teacher that is approachable, I think that is the biggest thing for me. That and having hands on curriculum I guess. Just my relationship with the teacher. Even if there is a negative relationship that doesn't necessarily reflect on my grade it's just how much I have a passion for the class and my dedication.

Connor's bioscience teacher, Bruno Sunbell, stated additionally that Connor does approach him about STEM careers, even though Connor did not explicitly mention the bioscience class. Dr. Sunbell discussed the opportunities the bioscience class gave to students like internships and

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STEM careers students might not previously know about. Connor mentioned previously when discussing the bioscience class, it was a good opportunity to hear about different careers and opportunities. Dr. Sunbell added Connor is one of his students to jump at the opportunity when given. To understand a sense of mentorships, I asked Dr. Sunbell if he saw a future relationship outside the class to which he responded he could see it happening.

Interviewer: Does your student approach you about STEM careers?

Dr. Sunbell: Um, when prompted, you know. As a result of the grant we really do make a concerted effort to try and bring in, you know, opportunities to outside of just the day-to-day activities: so internship opportunities, you name it, uh, professional talks, so forth. And when asked or prompted he's definitely the first to jump at them.

Interviewer: Do you think you will remain in contact with this student after he/she leaves your class?

Dr. Sunbell: Oh absolutely, he's one of the teams that qualified for the health occupation and student association, so yeah, I mean, I definitely foresee that beyond this course.

Barriers/unsupportive influences. Students faced a variety of barriers and unsupportive influences throughout the year, and in Connor's case, it revolved around logistical barriers such as money and paying for college. During Interview 1, Connor made little mention of barriers or unsupportive barriers. When pressed to think about people who might prevent him from accomplishing his goals, Connor denied the influence of friends to prevent him from doing so, but added money could be an issue, though he would persevere. Connor mentioned logistical barriers in more depth during Interview 2. He stated money was an issue, though an issue for many students. He added the solution to find the opportunities to get through college without having to take out extensive amounts of loans. Connor elaborated more on the issue of money

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later in Interview 2 when asked about supportive influences from his family. Connor missed a scholarship opportunity due to grades, and discussed how his parents were disappointed.

Interviewer: Do you think any people might prevent [you from accomplishing your goals], beside yourself?

Connor – Interview 1: Um, I don't think so. It's kind of my choice. Money definitely but we can always push through that

Interviewer: What kinds of events, situations, and people may prevent you from reaching your goals?

Connor – Interview 2: Um, probably just money I think which is an issue for everyone. Um, just kind of looking for those opportunities to get through the door and not having to take out a bunch of loans, be in debt for the rest of your life.

Interviewer: What sort of conversations do you have with parents/guardians about your future education & career plans?

Connor – Interview 2: I think most of it revolves around money, probably, which is kind of sad. I know I missed out on the Lumberjack Scholarship because I wasn't, I didn't know about it when I first started school, so I fell short by one C which is really painful because it's your whole undergrad for free. They were a little upset about that . . .

Religion. Connor indicated a strong influence of his religious affiliation in Interview 1. Culturally, he felt no influence, yet religion influenced him to help those around him. He stated he wanted to help people because of his religion, and that it was a part of why he wants to go into eye care. He elaborated on making connections with people to improve their way of life. During Interview 2, Connor identified as a Christian, and once again stated his culture was not an influence in his decisions, but made the connection between his faith and his desire to help others

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through healthcare. He indicated his Christianity might affect the reason why he wants to help people.

Interviewer: In your opinion how have your cultural beliefs influenced your career interests and expectations for what you can accomplish in the future?

Connor – Interview 1: So cultural, I guess not so much cultural, but religion has definitely shaped you know I want to be able to help people and to improve their lives. And that's kind of just my religious background.

Connor – Interview 2: I don't think any of my cultural stuff really affects any of it. So I'm a Christian so I guess you know bettering people's lives so I think that has influenced me into the healthcare so, you know, instead of just doing like civil engineering. So I just want to improve people's day-to-day lives. I think that might affect it.

Interviewer: So you feel like your religion is a part of what you want to do?

Connor – Interview 1: Yea for sure, I definitely want to, you know whatever I pick I want to definitely be a social career, and make more connections with people, and to just make their life better. Especially with eye care it's a huge part of your life, you know, so by improving that you are making their life better.

Connor's mother, Mrs. Patterson, commented on his involvement in and influence of his faith. She elaborated on his desire to serve people through mission's work, and he went to Mexico to help build houses. I asked Mrs. Patterson if Connor went on any medical mission trips, which she responded he had not, but her husband had since he was a nurse. She stated he went to Peru several times, and knew Connor wanted to serve on a medical mission's trip. Mrs. Patterson voiced her reservations about Connor joining since he did not have any medical skills.

Interviewer: What are your child's hobbies?

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Mrs. Patterson: He's gotten involved in church. We do a lot of mission work, so he's been on a lot of Mexico house building trips and service trips, which he loves.

Interviewer: Has he been able to do any medical missions trips?

Mrs. Patterson: Um, he has not gone on any of those, my husband has. He's gone to Peru a couple of different times. He's a nurse; my husband is a nurse at the hospital. But Connor hasn't been able to be a part of that. We would love to, yeah, in the future and include him in that. It's just hard because he doesn't have any medical skills really at that point.

Perception of Self as Student. Connor described himself as a good student, only lacking in motivation to go to school in the morning. He described that since the school policy is getting stricter, it helps him have the motivation to go to school. He stated he gets A's and B's in his classes, with an occasional C in a class which he has no interest. Connor remained active in band throughout high school. When asked if he was interested in school, he responded that he loved learning, even when he had a teacher he did not like. He commented on his leadership roles in two programs he was a part of in middle school and high school.

Interviewer: Could you describe yourself as a student?

Connor: I am really awful at attendance. That's probably my worst quality/trait. Just cause, I don't know, just finding that motivation to get up and go in the morning and make it on time. The school policy is super strict on that like it's getting intense with (school district) so I'm glad. I'm usually there every day, it's just getting there on time. Um, I'm a pretty good student, A's and B's usually. I only have a couple C's in weird history classes because history is my least favorite subject ever and I don't ever want to

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take [another] history class. Oh gosh, um, active in different activities like band, it's a really big part of my life. Community band and stuff like that.

Interviewer: Are you interested in school?

Connor: Um, yea I love learning and stuff. And of course you run into those teachers you don't like but it's just the whole experience of learning. I did a lot of leadership courses like MITE and CIT so just kind of that engineering and science.

The SAM instrument involved an extensive amount of questions regarding how the student felt about his level of confidence in science (Table 4). Connor initially agreed with being sure of himself in science and when faced with new science problems, he was confident because of his extensive background. Connor strongly agreed with his ability to draw upon scientific skills to solve problems and that he got good grades in science. Connor disagreed when posed with the statement that he does not attempt try a problem without referring to a textbook. Finally, Connor strongly disagreed with not doing a good job in science and that he is not the type of person to do well in science.

Table 4.

Pre-assessment SAM Instrument – Connor Patterson

Questions	Strongly Disagree	Disagree	Agree	Strongly Agree
I am sure of myself when I do science			X	
I can draw upon a wide variety of scientific techniques to solve a particular problem				X
If I am faced with a new scientific problem, I can cope with it because I have a good background in science			X	
Most subjects I can handle, but I cannot do a good job with science	X			

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I get good grades in science				X
I do not attempt to work a scientific problem without referring to a textbook or class notes		X		
I am not the type of person to do well in science	X			

In the post-assessment SAM instrument, Connor's answered differently in most statements (Table 5). Connor went from strongly agreeing he got good grades in science to only agreeing that he got good grades. He felt surer of himself when he does science, changing his answer from agreeing to strongly agreeing. He also changed his answer from agreeing to strongly agreeing when posed with a scientific problem, and was able to answer it due to his good background in science. Connor only disagreed with not doing a good job with science and not being the type of person to do well in science, whereas in the pre-assessment SAM instrument he strongly disagreed with both statements. However, he indicated in the pre-assessment SAM instrument he disagreed with not attempting a problem without referring to a textbook, whereas in the post-assessment he strongly disagreed.

Table 5

Post-assessment SAM Instrument – Connor Patterson

Questions	Strongly Disagree	Disagree	Agree	Strongly Agree
I am sure of myself when I do science				X
I can draw upon a wide variety of scientific techniques to solve a particular problem				X
If I am faced with a new scientific problem, I can cope with it because I have a good background in science				X

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Most subjects I can handle, but I cannot do a good job with science		X		
I get good grades in science			X	
I do not attempt to work a scientific problem without referring to a textbook or class notes	X			
I am not the type of person to do well in science		X		

Connor, according to the SAM instrument and Interview 2, indicated a strong sense of confidence in his skills within science. He felt confident in math and science, especially in the advanced programs. He commented on how he was not the top of his class, but he was still in those advanced classes and remained average throughout the class. I asked him if he felt like his confidence was changing since being in the bioscience class and programs like he did in middle and high school. Connor responded that he felt it was changing, yet the higher levels are much harder and the students are very passionate very science.

Interviewer: How skilled do you feel?

Connor: I think it's, I feel pretty skilled. Math and science are my strongest so I've always been in higher programs and stuff. I'm not usually the top kid in the class, but I'm in a higher excelled program, so I'm usually in the middle so that's good.

Interviewer: Do you feel like [your confidence] is changing because of classes like [the bioscience class] and CIT?

Connor: Yeah I think it's changing. It's harder the higher you go up because everyone, like, also has a passion for that so I don't know

Dr. Sunbell reaffirmed this changing sense of confidence when asked if he was able to see Connor grow in the class. Dr. Sunbell commented that Connor's confidence and

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communication was growing. He voiced his opinion on the relationship between confidence and communication and how the class has improved this relationship not only in Connor, but also the entire class.

Interviewer: Were you able to see Connor grow in science knowledge/confidence throughout your class?

Dr. Sunbell: Oh yeah and I think with that also confidence along with just communication. You know, that's a big piece of the science realm that I think a lot of scientists today, whether it's the clinical side or the research clinical side, they lack that confidence and the ability to communicate. And I really, I mean, not just he, but I would say, all of our students in the course have improved with that, just as a result of you know the activities we designed.

Dr. Sunbell commented on Connor's sense of leadership and willingness to help others. He stated Connor took initiative when other students fell behind, which spoke to Connor's leadership skills. Dr. Sunbell discussed Connor's ability to formulate thoughts when answering questions. He stated Connor interpreted the material according to his experiences, which are then formulated, being another leadership quality within Connor.

Interviewer: Does this student volunteer in class to help others?

Dr. Sunbell: Absolutely yes. He's a natural leader in the course, in the sense that, you know, if you see someone struggling or if you just see somebody I don't know if falling behind is the right terms, but maybe if they haven't been there for a day, he'll always help them kinda get caught back up. So in terms of leadership, those are skills he definitely has.

Interviewer: Does Connor offer to answer questions you ask when lecturing?

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Dr. Sunbell: Yes, he does.

Interviewer: Are they well formulated thoughts or just off the cuff?

Dr. Sunbell: Very well formulated thoughts. And often times its interpretation, so it's "here's my interpretation of it" and he'll rely on other either course experience specifically to the bioscience class or he will rely on other life experiences, you can see the answer being formulated as a result to that.

Summary

Connor came from a strong background in STEM, not just academically, but also a strong family background tied to STEM. Because of his strong educational background, particularly in STEM, Connor seemed to provide little interest in the material presented in the course, yet increased motivation to finish the class. He came into the class with a sense of confidence, only to leave with the same level if not more confident. Evidence from Connor's friend, mother, and teacher indicated Connor seemed to have narrowed his focus as to which STEM career he wanted to enter once participating in the bioscience course. Though his parents were heavily involved with STEM, Connor felt little pressure to enter a STEM career because of their interest, and his goals were based off what he was interested in, and what he felt passionately. Though Connor personally established a lack of cultural influence in his career choice, Connor did feel influenced by his religion, which is arguably the same thing though he did not bridge this connection.

Milan Harris

Milan was a junior in high school, and attended the same high school as Connor Patterson. He identified as Native American with strong ties to his cultural background. His

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parents received an education up to the 12th grade, not graduating from high school. Milan's dad worked at the local hospital as an anesthesia technician and his mom worked at a motel as a housekeeper. During Interview 1, Milan stated his career goal was to be a paramedic, and take emergency medical technician (EMT) classes. He had a strong calling to help his community on the reservation he called home. I selected him in my sample based on his interest in the bioscience class as well as his instrument responses, CIQ, SAM, and STEM Semantics.

Educational and Career Planning. Milan's interest in science was demonstrated in his response to the pre-assessment CIQ instrument. He strongly agreed when posed with the statements, "I would like to have a career in science" and "I would enjoy a career in science." His answers remained the same in the post-assessment CIQ instrument. Milan affirmed this answer during Interview 1. His desired job after high school would be to become a paramedic. Milan commented in order to achieve this goal, he must advance his education, obtain volunteer hours, and take EMT courses. For clarification, I asked if becoming an EMT required certification through a program, which he confirmed. Interestingly, in Interview 2, when asked what his career goals were at this point, he mentioned being a paramedic once more, however, also discussed his desire to become a registered nurse (RN). When asked what his ultimate career goal would be, Milan stated he wanted to be an orthopedic doctor, however, it would be a vast amount of schooling. Milan's scope of knowledge in STEM fields widened throughout the bioscience class. His ambition to become a paramedic was evident, but his range of career opportunities expanded.

Interviewer: Do you have some ideas on what you would like to do after high school?

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Milan – Interview 1: Right after high school I want to become a paramedic so I am trying to exceed my education so I can get some volunteer hours and take some EMT courses in order to get my certifications and skills and CPR and hopefully get accepted

Interviewer: Is becoming an EMT a program in itself?

Milan – Interview 1: Yes

Interviewer: What are your career goals at this point?

Milan – Interview 2: I want to be either a paramedic or an RN, registered nurse.

Interviewer: What job do you want to most end up with?

Milan – Interview 2: Uh, either an orthopedic [doctor], but it's like 12-16 years of schooling or something like that.

I observed Milan's career choices from the beginning of the bioscience to the time he did Interview 2, and I noticed a more focused career path. Milan's friend, Melanie Baumann, noted how Milan narrowed his path down from the time she met him. Melanie noticed he was more nonchalant about what he was going to do in life, even when she suggested he make a plan. Once he started planning his life, she stated he narrowed it down to a medical or science field. She encouraged his plan, and suggested he should keep developing that plan. Melanie reflected he continued developing his plan, which is a reason why he attended the bioscience class.

Interviewer: From the time you have known your friend, how have you seen him/her grow in interest for STEM careers?

Melanie: Well, it's kinda liked narrowed down from like when I met him. He like he wasn't sure what he wanted to be when I first met him. He was just kinda like, uh, life happens. I'm like, life does happen, but you can plan it out you know that. And then he started to plan it out, and then he started narrowing it down to like medical or science

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field. And I was like, yeah that's a good way to start and then you just keep going from there. And then that's what he's been doing and that's why he came to this class and everything.

Dr. Bruno Sunbell, the bioscience course instructor, also commented on Milan's career choices. When asked if Milan approaches him about STEM careers, Dr. Sunbell explained how he does, and how Milan initially picked a career path he was not sure he wanted to do at the point of the interview with Dr. Sunbell. He commented on how Milan still wants to enter a healthcare route, but Dr. Sunbell voiced that Milan's horizons have opened up to a surplus of opportunities for Milan to consider. When I asked if he thought it was because of the bioscience class, Dr. Sunbell exclaimed how it was, and how Milan has vocalized this to him.

Interviewer: Does Milan approach you about STEM careers?

Dr. Sunbell: When it does relate to career avenues. It's interesting because what he wanted to do before, he doesn't know if that's the path he wants now because he sees that there's so many more opportunities. He still wants to go the healthcare route, but before it was only paramedic. And now, "well there are so many other things to do, I just don't know what I want to do now."

Interviewer: Do you feel like this class has contributed to that?

Dr. Sunbell: Oh he's vocalized that! Yeah, it's definitely, I mean, anecdotal qualitative evidence, but yes.

Milan's father, Mr. Harris, voiced the exact same reasoning as Dr. when questioned if Milan comes to him to talk about future plans. Mr. Harris discussed how Milan has decided to become a doctor, yet decided to change again, but stay in the medical field. Mr. Harris stated Milan has been given the opportunity to see different types of scientific careers, which could

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advance him. He said because of the bioscience class, it has opened Milan's eyes and broadened his views on STEM careers.

Interviewer: Does Milan talk about future plans with you?

Mr. Harris: He's really focusing on, well he said doctor at first, and now he's kinda interested in staying in the medical field and go from there. Cause there's so many opportunities now, that he kinda got the jumpstart on everything and then, uh, this is, this CAVIAT program kinda opened his eyes up to see what else is out there.

Mr. Harris continued discussing Milan's opportunities throughout the summer, whether that is job shadowing Mr. Harris at the hospital since he is an anesthesia technician or partaking in a medical internship. He described his line of work as a sterile environment, which Milan enjoyed. When asked about how Milan talked about college with him, Mr. Harris stated Milan did not talk with him about college, but he did receive an internship opportunity at a state university. When questioned as to how Milan heard about the internship. Mr. Harris answered that his bioscience teacher informed him; Milan applied, and was accepted.

Interviewer: Does Milan talk about future plans with you? (Continued)

Mr. Harris: I want him to job shadow me so he knows what I do, because I work in like a sterile environment and he's really interested in that, so only for the summer time he can come up and have a chance and spend a day with me.

Interviewer: Does he talk about where he wants to go to college with you?

Mr. Harris: Uh, No not really. But this is his first time experiencing the U of A Tucson this summer, so maybe that's something he can go into.

Interviewer: So he got an internship? At the University of Arizona?

Mr. Harris: Yeah, he got an internship.

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Interviewer: How did he find out about that? Did you find out about the internship and suggested it to him or did he find it and was like 'I want to do this'?

Mr. Harris: Oh, this was at uh, I think his CAVIAT teacher mentioned it to him and he went from there.

Interviewer: Ok, so his bioscience teacher suggested it to him and he applied and then got accepted?

Mr. Harris: Yeah.

A concern of mine throughout the study was pressure from parents because of career or education status. I reflected on Milan's pre- and post- assessment CIQ instruments. When posed with the statements, "My family is interested in science courses I take" and "My family has encouraged me to study science", Milan strongly agreed with both statements in the pre-assessment CIQ instrument. However, Milan's opinions shifted slightly in the post-assessment CIQ instrument, he only agreed with the same statements. Mr. Harris and his wife did not finish high school, and Milan discussed in both interviews that his parents are surprised by how much potential he shows in science. Milan also stated his parents want better for him than they were able to create for themselves since they were not given this opportunity. During Interview 2, Milan discussed that his parents were motivators to keep him going. Milan reflected on even though they do not know everything, they helped him regardless. He continued in Interview 1 when asked about how his parents helped him think about future careers, stating they actively asked him about it, and help him think through different career paths. During Interview 2, Milan once more reflected on how his parents motivated him and supported him due to them not finishing high school, and to make a better life for himself. Milan viewed his parents as a motivating and supportive unit when it came to what career path he would take.

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Interviewer: What sort of conversations do you have with your parents or guardians about your future education and career plans?

Milan – Interview 1: They're just really astonished with how much I have done cause both of them haven't graduated high school and they try their best to help me and they're just really surprised how much I have in me and how much potential I have for the future

Milan – Interview 2: Um, I kinda talk about what I want to do and they are really astonished with what I'm doing because they never had the opportunity that I had. They are just kinda, they are keeping me motivated to keep going. They don't know how to do these things or how to lead me the right way, but they just kinda help me still.

Interviewer: Do they help you think about future careers?

Milan – Interview 1: Yes, they always ask me every day when I get done and they help me out.

Milan – Interview 2: Yeah just motivation and support because they didn't finish high school and, um, they kinda tell me to go beyond all of them, but they kinda they went on their own separate ways. So I don't really know who to ask so I stick with my dad and grandpa to help me get there.

Mr. Harris confirmed when asked if a STEM career would be a good path for Milan. He discussed how it would be a career he would like to see Milan go into, and he will support him no matter what career Milan chooses. He stated he would let Milan decide, but will always help him and hoped it would make him a better person rather than forcing him into a career he does not want. Mr. Harris reflected on how he should have gone through several opportunities himself, and because of this he allowed and encouraged Milan to do what he was not able to do. Mr. Harris alluded to the fact Milan is capable of figuring out what he wanted to do, and

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concluded he wanted Milan to be happy rather than picking a career for him that would make him unhappy. Interestingly, when asked if he felt like he pushes Milan to enter a STEM career, Mr. Harris agreed, yet still remained grounded in being content with whatever Milan chose. As long as Milan was committed, and understood it would take hard work, Mr. Harris would be supportive. He discussed Milan's dedication to the bioscience class, and how surprised he was to see him in the class, even though it consumed Milan's time. He was impressed with Milan's dedication to the class, which helped prove the importance of hard work going into a STEM field.

Interviewer: How do you feel about STEM fields and is that a career choice you want for your child?

Mr. Harris: Uh, most definitely any kinda career I would like, but if something catches his eye I'm not gonna hold him back and say "hey you should do this or do that" I'm gonna let him decide if he wants it, I'm gonna help him get it. But, uh, I want him to grow as a person with that one, instead of being forced into something he probably don't even like or no interest. So I'm letting him catch a eye of any educational, any career, any job training, I mean just letting him do it, so he, um, basically, stuff I should have done, I'm letting him have his own choices, instead of being thrown in the mix of no clue. But he's still kinda doing that right now, but then he kinda figured out if he doesn't like it or if he wants to try something new.

Interviewer: Ok, so just kind of encouraging him, but at the same time making sure he's happy? Picking something he wants to do?

Mr. Harris: Yep, that's it.

Interviewer: Do you find yourself pushing your child more towards a STEM career?

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Mr. Harris: Yeah, definitely. If it's something he likes, he can, I mean, I'm not going to say no to it. I'm just going to encourage him more and say "Hey, it's gonna take hard work," cause just like the CAVIAT program. I mean, I wouldn't have even thought that he would have time to do that after school 4 days, 3 days a week and be committed. See it takes a lot you know, everyone gets out of high school and 2:30, 3 o'clock comes, they don't want to go back to school again. And I'm like, so I mean, this is like, uh, a moment of how dedicated he was for like a half a year almost a year doing it.

Identifying Connections to Future Work/Goals. Milan also elaborated very little on this section, but what he identified was a connection to his work ethic, and he will maintain that in the future. He also identified how being social will help him later in his career. Milan strongly agreed with the statement, "Doing well in science is important to my future" in the pre-assessment SAM instrument. He indicated the same answer when posed once more with this statement in the post-assessment SAM instrument. Milan clearly understood this connection was important. In Interview 1, Milan identified himself as competitive and challenges himself because he enjoys completing work. He also stated he enjoyed helping people, which he believes he will still enjoy in the future. Milan discussed how communication and his sense of humor will remain intact as well. During Interview 2, he emphasized the importance of communication, and the social side of his personality. When asked how this will help in the future, Milan elaborated on the fact that socializing will benefit him by getting his name out in the community, which may allow him to network and receive help and encouragement.

Interviewer: What is the connection, if any, between how you are as a student now and your life in the future?

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Milan – Interview 1: Um, I am very challenging and competitive, I like to get work done. I actually like to help people so I see that's still with me. And communicating a lot, joking around, so I think I will still be there.

Milan – Interview 2: Being very social, talking to people and helping people out. And challenging myself, that's what I see in the future.

Interviewer: You're pretty social now it seems, so how do you think that will help you in the future?

Milan – Interview 2: Um, getting to know people is starting to benefit me even now. Because they all know how much I do, and they are always there to help me all the time and giving advice as to what to do and what not to do.

STEM Experiences. Milan did not have as an extensive STEM background as Connor. Though interested in advanced science classes, Milan only took what was required, yet considered advanced placement (AP) STEM classes. When asked what classes he has taken, Milan stated he took Chemistry at the time of Interview 1, which he enjoyed. Math was something he also enjoyed, and he stated Chemistry consisted of a substantial amount of math. He took Biology previously, which he did not enjoy as much as Chemistry. Milan commented that the material was the issue, rather than the teacher. He took Pre-Algebra 2 at the time of Interview 1, and tried getting into AP Calculus or AP Statistics. He previously took Geometry, and took Auto and Welding at time of Interview 1.

Interviewer: What has your experience been in school with courses/classes in science, technology, engineering and math (STEM)?

Milan – Interview 1: I'm taking chemistry right now . . . I feel very positive about it. It's a lot of math, and I like math. I took Biology.

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Interviewer: Did you like it?

Milan – Interview 1: No, not really. I wasn't into kinda organisms and lives. . . I think it was just kinda the subject. The teacher was cool.

Interviewer: So you are more interested in Math and Chemistry?

Milan – Interview 1: Yeah, I'm taking Pre-Algebra 2 right now. I'm trying to get to AP Calc or AP Stats, and I took geometry before this . . . I'm taking Auto and Welding, but that's it.

Asked if he explored any other STEM fields besides the bioscience class, Milan stated he had not, but was active in sports. He did wrestling, football, and marching band. When asked why he did not explore any more STEM programs, he commented that it was due to sports, yet stopped sports to become more involved with advancing his education. Milan was asked these same questions in Interview 2, and he commented that he was going to do an EMS class at the community college, yet missed the deadline so decided to take the bioscience class. Milan stated since he tore his ACL in football, he needed to do something with his spare time while he healed. He joined clubs and eventually found this class. Since his ACL surgery, he had decided to put sports aside and focus on his education.

Interviewer: Have you explored any career interests in STEM fields in the past beyond this bioscience course?

Milan – Interview 1: Uh, the only programs I have done is wrestling, football, and marching band, that's pretty much it.

Interviewer: Has anything stopped you from exploring other STEM programs?

Milan – Interview 1: Just sports, but I kinda stopped doing that so I could do more of these classes.

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Interviewer: Have you explored any STEM fields in the past beyond this bioscience course? If so, what prompted you to explore those fields?

Milan – Interview 2: Uh, I was either was going to do, well, before I joined this class, my first thought was joining an EMS class at CCC, but I was late for that so I took this one instead.

Interviewer: What prompted you to do so?

Milan – Interview 2: So sophomore year I was playing football, and I tore my ACL. I still wanted to do something instead of just going home and rest my leg. I wanted to do something so I started joining clubs, and got an email from a teacher doing CAVIAT, and wanted to take more credits so I kinda got in there.

Interviewer: Do you still play sports?

Milan – Interview 2: Um, I've kinda given up on sports and focusing on school now.

Bioscience Course Reactions. Milan attended the bioscience class offered through CAVIAT from the start of the class, to the following May, when it ended. Milan reflected on his time in the bioscience class during Interview 2, and discussed how the class was revealing him to different people and opportunities within STEM. He commented on meeting new people and having opportunities he would have never had before. When asked what was interesting about the class, Milan praised the bioscience instructors. He enjoyed developing a relationship with Dr. Sunbell and the second instructor, Elias Tritten. Milan previously knew Dr. Sunbell from middle school, but had yet to meet Elias. With the help of Dr. Sunbell and Elias, Milan enjoyed the relationship with them through helping him understand science.

Interviewer: What have you liked about the class?

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Milan: What I liked about the class is that, kinda getting more out there into school and stuff, because all I was doing sports and nothing else. And now I'm kinda opening up my views into the health and sciences part, and help me get out there more, and getting to know more people, and doing more things than I could have had before I took this program.

Interviewer: What has been particularly interesting about the class?

Milan: I really like this class because of the teachers because I got to know them really well. I already knew Dr. Sunbell already, when I was in middle school. And getting comfortable with Elias and just seeing having them helping us out and helping me understand more what the science field is about.

A common theme Milan discussed throughout Interview 2 when talking about his most satisfying accomplishments in the bioscience class was the amount of networking he had done, and putting his name out to the community. He commented on once he started the class, people started noticing what he was doing. Milan had run for president of Health Occupations Students of America (HOSA) and was elected, and once again got elected to represent Arizona at a conference in Boston the following summer after the bioscience class. The opportunities started opening up for Milan, and he took notice.

Interviewer: What is the most satisfying accomplishment for you in taking this class?

Milan: I guess getting me out there into the public view, because once I started taking this class, a lot of people starting knowing [what] I was doing more. A lot of people started noticing that I was doing more rather than just doing sports. Because I got elected as a president for [HOSA] I was kinda happy about that, I got elected again for being a

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delegate of Arizona in Boston over the summer for representing us, and kinda seeing how much is done going to this class helps me get out there more.

As mentioned previously in Career and Educational Planning, Milan had a wider scope of STEM opportunities opened up to him through the bioscience class. The impact of the bioscience class was substantial for Milan, and it was a common theme I found when I interviewed Dr. Sunbell, Melanie, and even Mr. Harris, as discussed earlier. When I talked with Dr. Sunbell, he mentioned that when Milan started the bioscience class, he wanted to take a few classes at a community college, receive EMT certifications, and become a paramedic. Once he was in the bioscience class, Dr. Sunbell noticed he started talking about medical school, since it was in his realm of possibilities. He bragged on Milan becoming the HOSA president, which was a surprise to him, and noticed the amount of confidence and maturity Milan gained. Milan also was accepted into a medical internship, mentioned previously, which Dr. Sunbell stated proudly. When asked if Milan would have applied for the internship prior to the bioscience class, Dr. Sunbell adamantly stated he would not. The amount of opportunities Milan was exposed to would not have been possible if not for the bioscience class. Dr. Sunbell followed the same theme Milan had mentioned, in that if not for the bioscience class, his communication would not have been enhanced, and he would not have exposed himself to the scientific community. Dr. Sunbell voiced his thoughts on the responsibility of educators, and how educators should teach students to think that they can always do better than what they previously thought.

Interviewer: Were you able to see your student grow in science knowledge/confidence throughout your class?

Dr. Sunbell: Oh yeah, I mean, when he initially walked in, it was "well I'm only going to do this entry level position" and now it's "well I want to go to medical school, or "I

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wanna...” It's much more grandiose and doable. The president of HOSA was a true surprise, him running for that. That was a sign of mature growth and confidence that has been gained. And I don't know if we can say it, but he got accepted to a medical internship down at the U of A that he had been applying for, and he just last week just found out. So it was super rewarding to hear.

Interviewer: Do you feel like he would have applied for [the internship] if not for this bioscience class?

Dr. Sunbell: Definitely no, I don't think he would have without being involved in this course. I'm really going to be excited to see how it turns out at the end of the year where we look at all of the students and the different internship opportunities. With Milan, it's been not only the ability to enhance his communication, but also the ability to expose him to more than just status quo, and I think as educators and what I'm finding is, it's ok for students to go "I can be better than what I thought" and really dream big and go for it. We just gotta teach them how to do it.

Melanie expressed very similar thoughts when discussing the impact of the bioscience class and his career. She thoughtfully examined the different opportunities the bioscience class has given to her and Milan. Melanie described a training she and Milan attended, then a lecture on Ancestry DNA and explained how Milan thought it was a cool lecture, alluding to doing that as a future career. She expressed her support of it, and was asked if he was looking at specialized fields within science. Melanie stated that he was because of the opportunities given to him in the bioscience class. When asked if he was growing away from being an EMT and considering all the other possibilities within science, she confirmed this conclusion.

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Interviewer: Has this bioscience class allowed Milan to narrow down what he wants to do?

Melanie: Well, he wanted to come in here being an EMT, but then now he is just like, “What?” He didn't know about, like, this science thing. Cause we were given an opportunity to go to the SEM, the thing that we went to last week. And he thinks that's really cool. And, like, you can mess with that for hours and never get bored. Or we went to, um, what was that thing called? It was called, like, Ancestry DNA. It's like somewhere around NAU. He thinks that's really cool too about researching, like, cause they're researching, like, bat poop, and he thought that was funny and cool at the same time. And I'm like “yeah, I guess you can do that if you want.”

Interviewer: So he's now looking at specialized parts of science?

Melanie: Yeah, all the experiences that we're given in this class he's like looking at them, and just like “wow that's cool, wow that's really good,” and I'm like “yeah!”

Interviewer: So it's definitely science related? And he's kind of grown from EMT to seeing all these possibilities?

Melanie: Yes.

Impact of Student Identity. Student identity was a large theme discussed during student interviews. For this research, cultural background, gender, resources, and barriers/unsupportive influences are examined below.

Cultural background. Milan's cultural background related to what he wanted to do in the future. He identified as Native American in Interview 1. Milan discussed how no teachers treat him differently because of this, and would not want to be treated differently than any other student with a different cultural background. He stated his teachers are very respectful of his

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beliefs, though, and they make sure to consult with him before doing any type of lab activity that may compromise his beliefs. When asked to expand on his cultural and religious background, Milan discussed what he was unable to do such as touching dead animals, skeletons, and similar things. His teachers respected this aspect of this life, however, and Milan made an effort to distinguish this in the interview. Milan was also asked if his cultural background influenced what he wanted to accomplish in the future. He responded that he wants to return to his reservation to help his community. Milan explained the reservation had two hospitals the community had to rely on, and that he wanted to return to be a paramedic and help. During Interview 2, Milan stated the same reason why he wants to go into the medical field. Though he explained it was not necessarily due to his cultural beliefs, he stated his culture needed help, which he would go back to do.

Interviewer: Please tell us about your cultural, ethnic, and racial background. How do you identify yourself in terms of race and ethnicity?

Milan – Interview 1: Um, I identify myself as a Native American. Um, my teachers know that they, they don't really take it like I should be specially treated, they know that I should be treated like everybody else. I would like that, to be treated equally, whether it's Black me, or White me, or Mexican me, it doesn't matter. They are very respectful of my culture, and even my religious background, and they are really respectful of it

Interviewer: Could you elaborate on your cultural background and religious background?

Milan – Interview 1: Um, like either we have some activities going on in, like, biology, like, touching dead animals, touching skeletons, or things like that. They actually ask us individually to see if we are allowed to do this activity and I respect that.

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Interviewer: In your opinion, how have your cultural beliefs influenced your career interests and expectations for what you can accomplish in the future?

Milan – Interview 1: When I go back to my home, I realize there is not a bunch of medical kind of things going on out there. There are only like 2 hospitals that each one, every reservation relies on, whether Tuba City or Flagstaff so I think there should be more and that's why I want to be an ambulance guy and help out.

Interviewer: Ok, so when you say home, what home are you referring to?

Milan - Interview 1: My reservation.

Interviewer: In your opinion, how have your cultural beliefs influenced your career interests and expectations for what you can accomplish in the future?

Milan – Interview 2: Not really cultural beliefs, but with my culture and the few medical facilities and the lack of the whole healthcare providers, then maybe I can go back out there and help them out.

Interviewer: Do you think you'll come back when you get your degree?

Milan – Interview 2: Most likely.

Milan's ties to his community ran deep, even throughout the bioscience class. When asked if he felt supported by his friends, family, and community he emphatically agreed. Milan explained when he was talking to old friends in his community, they offered to ask their community to help pay for Milan's trip to Boston. He joked they are rooting for him since he was their golden boy. The interviewer asked if his community wanted to see him go into the medical field, which Milan said they did. He repeated the fact his community saw him as special, and had high expectations for him.

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Interviewer: To what extent do your family, friends, and community support your educational/career plans?

Milan: Oh yes, definitely. A lot of people I talk to, like, ever since I got elected to be a representative at a conference in Boston, I kind of talk to old friends, and they are able to ask other people if they can help me pay for my trip out there. They are kind of all rooting for me because they know me as a golden boy.

Interviewer: Is that something they want to see you doing, something in the medical field?

Milan: Oh yes!

Interviewer: What are your family and community's expectations of what you are to accomplish in the future?

Milan: They see me as special and think that I will make it far. But I'm just going to let that be whatever I want.

Gender. In the pre-assessment SAM instrument, Milan strongly disagreed with the statements, "Males are naturally better than females in science," and "I would have more faith in a science problem solved by a man than a woman." He shared the same feelings in the post-assessment SAM instrument. When posed with the statement, "Studying science is just as necessary for women as it is men," he strongly agreed with this in both pre- and post-assessment SAM instruments. Milan explained he did not think gender mattered within his family when questioned if his family's expectations were shaped due to his gender. His family consisted of all males, and Milan stated this did not matter, except that they all do their best. When asked if he was influenced to enter a STEM field because of his gender, Milan struggled to answer the question, since he did not believe it mattered at all. During Interview 2, When posed with the

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same question, if he was influenced to enter a STEM field because of being a male, Milan emphasized that he thought gender did not influence his decision. The interviewer asked if his interests were influenced by his gender, to which he denied.

Interviewer: How do you think your family's expectations about your future plans are shaped by the fact that you are a woman/man?

Milan – Interview 1: I don't think that really matters that I'm a [particular] gender cause our family is just complete boys but like just expect us to be our best. Better than what they have done basically so

Interviewer: How do you think your gender influences your interests and what you believe you can do in the future?

Milan – Interview 1: That's a hard question.

Interviewer: Do you think the fact that you are a male, does that influence what you want to accomplish?

Milan – Interview 1: Yeah, I guess, I don't know, it's hard to answer.

Interviewer: How do you think your gender influences your interests and what you believe you can do in the future?

Milan – Interview 2: I don't know; I don't think gender really matters with what I'm doing right now. I just kind of do what I have to do.

Interviewer: Has it influenced your interests at all and what you would like to do?

Milan – Interview 2: Not really.

Resources. A variety of resources were identified by Milan throughout his interviews. Milan talked about his family and friend support, but mostly support from his family. He acknowledged resources from his teachers, discussing how they would gather them and talk

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about different STEM fields and careers. Milan explained the teachers would help him figure out what job to enter based off the classes he was taking. When asked if his teachers support him, he agreed they did. Milan felt hardly any support from his counselors, and rarely talked with them.

Interviewer: What do you think will help you reach your goals?

Milan: Um, friends, family, they are always there to help encourage me all the time. They always wanna, kinda, what I learn they want me to have fun while I'm learning. That's basically where I'm at in this program.

Interviewer: What have you learned from your teachers in high school (not the bioscience class) about STEM courses and fields?

Milan: I've been, like, during school they always tell a few of the students from different programs about STEM different job and categories. Freshman year they kind of brought that in, and I was thinking about that. They're kinda, I don't know helping me know what I want to be based off the types of classes I am taking for my job so

Interviewer: Do you feel like your teachers support you in thinking about these careers?

Milan: Yes, definitely.

Interviewer: Also, what have you learned from your counselors about STEM courses and fields?

Milan: Not much. I rarely go to them for anything at all. I've only talked to them one time this year.

Barriers/unsupportive influences. Milan identified few barriers and unsupportive influences during Interview 1 that could impose on his career path. He stated once more the people in his life were there to encourage him and make sure he is trying his best. Milan emphasized how they were there to reach his goal. He identified a health issue that could hinder

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his goals, yet he did not think it would stop him from his desired career. During Interview 2, he stated again how there was hardly anything that would get in his way. He seemed to focus on the positive side of accomplishing his goals, even if his school work was stressful. Milan was driven to accomplish all his goals.

Interviewer: What kinds of events, situations, and people may prevent you from reaching your goals?

Milan – Interview 1: I don't know exactly, um, I don't think I have any. They are all there to help me and encourage me and want me to try my best to get to my goal. Just some minor [situations], I injured myself in football and I don't know if that could hold me back when I do paramedic.

Milan – Interview 2: Um nothing much, I've kind of been going down that streak of accomplishing a lot of things right now. Just kinda, it gets stressful and a lot of work to do but I get it done.

Perception of Self as Student. Milan explained his attendance in school was good, going to school every day and being active in class. He took AP classes, though he did not want many AP classes. He stated he was keeping his grades high, so that he could get scholarships for college. Thankfully, he mentioned he was having fun in school. Milan was aware his teachers appreciated him in class, since he was a student who would talk. He emphasized his confidence, stating he does well and has always done well because he feels motivated.

The SAM instrument involved an extensive amount of questions regarding how the student felt about his level of confidence in science. Milan only agreed with the statements, “I am sure of myself when I do science,” “I can draw upon a wide variety of scientific techniques to solve a particular problem,” “I get good grades in science,” and “If I am faced with a new

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scientific problem, I can cope with it because I have a good background in science” in the pre-assessment SAM instrument (Table 6). He strongly agreed with the statement, “I do not attempt to work a scientific problem without referring to a textbook or class notes.” Milan strongly disagreed with the statements, “Most subjects I can handle, but I cannot do a good job with science,” and “I am not the type of person to do well in science.”

Table 6

Pre-assessment SAM Instrument – Milan Harris

Questions	Strongly Disagree	Disagree	Agree	Strongly Agree
I am sure of myself when I do science			X	
I can draw upon a wide variety of scientific techniques to solve a particular problem			X	
If I am faced with a new scientific problem, I can cope with it because I have a good background in science			X	
Most subjects I can handle, but I cannot do a good job with science	X			
I get good grades in science			X	
I do not attempt to work a scientific problem without referring to a textbook or class notes				X
I am not the type of person to do well in science	X			

Milan answered quite differently on the post-assessment SAM instrument (Table 7). He maintained his answer of agreeing with the statement, “I am sure of myself when I do science.” He changed his answers to the statements, “I can draw upon a wide variety of scientific techniques to solve a particular problem,” “I get good grades in science,” and “If I am faced with

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a new scientific problem, I can cope with it because I have a good background in science” from agreeing, to strongly agreeing in the post-assessment SAM instrument. Milan remained unchanged in strongly disagreeing with the statements, “Most subjects I can handle, but I cannot do a good job with science,” and “I am not the type of person to do well in science.” Most interestingly, in the pre-assessment SAM instrument, Milan strongly agreed with the statement, “I do not attempt to work a scientific problem without referring to a textbook or class notes,” yet in the post-assessment SAM instrument, he strongly disagreed with the statement.

Table 7.

Post-assessment SAM Instrument – Milan Harris

Questions	Strongly Disagree	Disagree	Agree	Strongly Agree
I am sure of myself when I do science			X	
I can draw upon a wide variety of scientific techniques to solve a particular problem				X
If I am faced with a new scientific problem, I can cope with it because I have a good background in science				X
Most subjects I can handle, but I cannot do a good job with science	X			
I get good grades in science				X
I do not attempt to work a scientific problem without referring to a textbook or class notes	X			
I am not the type of person to do well in science	X			

When asked what he thinks helps him do well during Interview 1, he stated he did not know, but felt encouraged to do the work. Interview 2, Milan elaborated, stating he was very

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social and liked to challenge himself. He recognized how much he liked to help people, and that it improved his mood for finishing his work. Milan was asked how skilled he felt in his science classes. He did not give a direct answer during Interview 1, stating he was active in science, and most people came to him for help throughout the class. I asked if he felt confident, to which he replied he did. During Interview 2, however, Milan seemed to have a confidence boost, answering the question directly, stating he felt very skilled in his STEM classes.

Interviewer: Can you tell me a little bit about yourself as a student?

Milan: My attendance is very well, it's 100% right now. And I'm taking higher classes, I'm taking advanced placement classes. It was more than I wanted. Pretty much I'm trying to keep the best grades for a scholarship right now and I'm just having fun doing it. All my teachers love having me in their class, I talk a lot in class. I definitely do well in school, always have. I feel motivated in school.

Interviewer: What do you think helps you the most to do well in school?

Milan – Interview 1: Just I don't know, I just kinda do it and feel encouraged to do it.

Milan – Interview 2: Um, I'm very social and I like to challenge myself a lot of the times. I'm kind of there for everyone. They ask me for help and I don't mind that. It kinda helps me get in a good mood, helping everyone and getting the work done.

Interviewer: How skilled do you feel in your STEM classes?

Milan – Interview 1: I feel very active. The seats usually in most of my class are in groups and a lot of people usually resort to me helping them and I usually like helping.

Interviewer: So you feel pretty confident?

Milan: Yeah.

Interviewer: How skilled do you feel in your STEM classes?

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Milan – Interview 2: Very skilled, I feel very good at it.

I wanted to understand how Milan's father and bioscience instructor viewed him as a student. During my interview with Mr. Harris, I asked if he thought Milan was a well-organized person and planned ahead. Mr. Harris confirmed that Milan did plan ahead, though he met deadlines not as often as he should. Mr. Harris stated Milan procrastinated by staying up all night to finish assignments, yet it seemed to work well for him and his grades. I asked if he felt like he did well under pressure, Mr. Harris said he assumed so, and reflected on how he wished he could do the same thing.

Interviewer: Is your child well-organized or plan ahead?

Mr. Harris: Yeah he plans ahead, but he's still gotta focus on deadlines, he's not really good at deadlines. Uh, I'll see the night before he'll crunch it out and he'll stay up half the night and knock it out. But next thing you know it seems like that works for him because he gets a good grade.

Interviewer: Yeah, so doing well under pressure?

Mr. Harris: Yeah, that's what I'm thinking. Like wow, I wish I had that growing up.

Dr. Sunbell reflected on Milan in class, and how he interacted with his peers. Dr. Sunbell described Milan as a natural born leader, particularly due to his motivation to run for a club president position. I asked if he took initiative and if he strives for leadership roles, to which Dr. Sunbell adamantly said yes. I inquired further, asking if Milan offered to answer questions and class and if they were well formulated. Dr. Sunbell explained he did, and that he based his answers off experiences, like most students. He made it clear Milan tried piecing bits of information together by sharing his thoughts with the class.

Interviewer: Does this student volunteer in class to help others?

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Dr. Sunbell: Yes. He 100% does. In fact, uh, natural born leader in the sense that you know, he actually ran for HOSA chapter president, so was elected by the class.

Interviewer: So he takes initiative?

Dr. Sunbell: Without a doubt.

Interviewer: And strives for those leadership roles?

Dr. Sunbell: Yes.

Interviewer: Does Milan offer to answer questions you ask when lecturing? If so, does he have well formulated answers?

Dr. Sunbell: Yes. I think [the answers] are developed, you know, what he'll do is he'll base it oftentimes on other experiences, like a lot of students do. You know, it's like, "Oh I heard this in this class," so he's attempting to connect the dots between disciplines. So definitely, I don't think they're on a whim. You know, they're formulated and thought through. At times they may not be the "correct answer", but it's a thoughtful answer, you can tell he's piecing it together.

Summary Milan had an entirely different reaction to the bioscience class than Connor.

What was most evident in interviews with him, his friend, father, and teacher was that this class opened up the scope of possibilities in STEM fields he could potentially go into. Milan had little frame of reference in regards to STEM careers prior to the bioscience class, however, once he entered and became a part of the class, Milan showed a deep interest beyond what he initially thought. Milan's support from his family and friends played a factor in his evolution, and the ties he had to his cultural community and interests motivated his decisions.

Connor had a strong STEM background and came from a family also heavily involved with STEM, therefore was adamant about entering an advanced STEM career. Milan, in contrast,

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did not have such a strong STEM background, his dad was in an entry-level technological field, however, Milan was not informed of advanced STEM fields until he entered the bioscience class. This course allowed him to explore a variety of fields and careers he could be interested in, changing his desire to enter a more advanced STEM career. Connor stated he felt no strong ties to his cultural background, yet felt his religious ties influenced his career choice. Milan felt the opposite, that his cultural background influenced his decisions to enter a career that could help his people.

The purpose of this qualitative study was to understand how two students from differing cultural and academic backgrounds evolved in scientific identity throughout participation in a bioscience class. The research questions were:

1. To what extent does the scientific identity of two high school students participating in afterschool bioscience course develop over a school year?
 - a. What are the differences in scientific identity development between an underrepresented minority student and a Caucasian student?
 - b. In what ways do the students' self-efficacy, interest, and motivation to enter a STEM career evolve?

Based off interviews and instrument gauging interest, motivation, and attitudes toward STEM careers, I saw slight change in Connor's scientific identity over the course of the bioscience class. As for Milan, there were interesting findings, and inferences I would suspect to be an evolution of his scientific identity.

These findings address the research questions, and displayed a difference between the two students stemming from different cultural and academic backgrounds. Though Connor had been involved with STEM for most of his life, he still wanted to enter a STEM field regardless

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because it was a passion of his. Milan had not been involved with STEM, yet also had a strong desire to enter STEM due to his interests and the awareness of his community's needs.

Discussion

This study aimed to examine how student identity and interest to enter STEM careers evolved in two high school student from differing cultural backgrounds attending a PBL bioscience class. Findings showed interactions between community partnerships and PBL resulted in a positive outcome of shaping and evolving student identity and interest to enter STEM careers. In this section, interpretations of the findings are discussed. Implications, limitations, and further research are described.

Interpretations of the Findings

Connor, who was the Caucasian senior in high school, felt there was minimal cultural background influence to his decisions, yet had a strong background in STEM experiences, creating a perceived lack of interest in the bioscience class material. However, he still felt motivated to finish the class and enter a STEM career as an ophthalmologist or optometrist, which he wanted to do since the beginning of the class. Milan, the Native American junior in high school, described strong ties to his cultural background, and though little mention of the class material was made, was interested in the opportunities the bioscience class had to offer. He gained a wider perspective of STEM careers, switching his career choice from paramedic to orthopedic surgeon.

Milan had a much more impactful experience than Connor did by developing a strong network within the scientific community, broadening his perspective to different STEM career opportunities, and utilizing his confidence from the PBI bioscience class to explore STEM fields. Community engagement was a major factor in the bioscience class, which Milan identified and

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gained a deeper understanding of STEM. Community partnerships created a sense of scientific identity, and crafted an environment for Milan to expand his knowledge and network for his future (Chemers et al., 2011, Gandara and Maxwell-Jolly, 1999, Hurtado, 1994, Bouillion and Gomez, 2001).

The formation of each student's scientific identity was different between the two students. However, both Milan and Connor were forming a social identity within the class, meaning they were thinking of themselves in terms of a member of a scientific community rather than a community based off of their unique characteristics (Hogg & Turner, 1987; Oyserman et al., 2017). This distinction is an important aspect of identity, as it allows students to feel accepted within the academic world, leading to successful futures and a sense of community (Davidio, Gaertner, Niemann, & Weiss, 2001). Both students gained an understanding of what was needed to enter a scientific community through experience, mentorship, and community partnerships (Brickhouse & Potter, 2001; Chemers et al, 2011). They were gaining self-efficacy in science and leadership, which in turn was demonstrated throughout the class.

Formation of Milan's Scientific Identity. Milan, with no strong background in science yet strong cultural ties, entered the class with the intent to enter a STEM career, though very unaware of other fields. He wanted to be a paramedic, but had very little information about other opportunities that could potentially be a fit for him. When he entered the bioscience class, Milan was exposed to what real scientists encountered. Through PBL, Milan was able to transform phenomena into real life situations, and was able to see science as relevant and within reach (Bell, 2010; Blumenfeld et al., 1991; Palmer, 1997). Milan had the opportunity to grapple with difficult questions to phenomenon due to his teachers creating this environment, and playing a

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role in the development of his scientific identity (Brickhouse & Potter, 2001; Krajeik & Blumenfeld, 2006).

The mentorship Milan received from Dr. Sunbell and Elias created a relevance of learning. The transition Milan made from an academic and sports community to a scientific community can be attributed to the help of his instructors. By creating an environment for Milan to experience science, struggle with tough questions, and open the door to community partnerships, Dr. Sunbell and Elias allowed Milan to develop his scientific identity in a safe and nurturing environment. Community partnerships with local hospitals, doctors, and organizations that promote scientific education allowed Milan to interact with prominent members of the scientific community, developing his sense of place as a scientist (Chemers et al., 2011; Gandara and Maxwell-Jolly, 1999). This class helped establish important relationships for Milan, which allowed him to network with fellow STEM colleagues and open his eyes to a variety of STEM fields and careers he could potentially enter.

Through the interaction with research, mentorship, and community partnerships, Milan's self-efficacy was nurtured and supported throughout the bioscience class. Milan indicated in his interviews that he felt more skilled than previously, and Dr. Sunbell confirmed this fact, stating Milan's confidence grew. MacPhee, Farro, & Canetoo (2013) stated that self-efficacy is a predictor of academic goals, and Milan's academic goals shifted from becoming a paramedic, to considering medical school to become a surgeon. Not only did Milan's scientific self-efficacy shift, but also his leadership self-efficacy increased. If not for the bioscience class, Milan would have never run for HOSA president, nor would he have been elected to be a representative of his state at a conference in Boston. This can only be attributed to his growth in self-efficacy due to his supportive community.

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Milan's cultural background played a role in this, as he was encouraged to enter a career in order to help his Native American community. In order to get to his final outcome, Milan's cultural ties influenced his decisions. With support from his family and community members, Milan accepted the help given in the bioscience class, cultivated a strong sense of self-efficacy, and was left with the commitment to enter a STEM career.

Formation of Connor's Scientific Identity. Though the bioscience class was impactful for Connor, it was not as dramatic as Milan's formation of scientific identity. Connor had strong ties to a STEM background, particularly because his parents were involved in STEM careers, and Connor strived to be a part of programs revolving around science. He was already set on a STEM career, either as an optometrist or ophthalmologist. Though the bioscience class was unlike his other classes, Connor had already been exposed to scientific research. He had been a part of programs connecting phenomena to real world problems, and Connor had a sense of what real science entailed.

One aspect shifting was his relationships with the instructors and community partners. Previously, he seemed to not have strong connections with his teachers, yet the bioscience class also broadened his horizons to different STEM fields and resources. Even with this new information, it is difficult to make a claim that Connor's narrowing of his career goals was directly influenced by the bioscience class. Connor's self-efficacy in the class seemed to have either remained the same or increased slightly. He stated in his interviews he felt more confident and capable, yet with his previous science classes, Connor had a strong sense of confidence because of his involvement.

Though Connor had a strong scientific background, he did not feel his cultural background influenced his decisions to enter a STEM career unlike Milan. He made distinctions

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that his religious background played a role in influencing his career choices, which one could argue is a part of his culture. Though Connor kept denying a cultural influence, the impact his religion makes on his decisions would argue that his culture does influence him making it clear there is a disconnect between these two concepts for Connor. Connor's initial decision to enter a STEM career was maintained throughout the bioscience class yet was more committed by the end of the school year. Through experience, mentorship, and community partnership, Connor's self-efficacy seemed to increase, leading to a strong commitment to enter a specific STEM career.

Flow Model Application. Previous research has shown the formation of scientific identity develops with the help of support components (mentors, teachers, community partners, etc.), leading to psychological processes (self-efficacy, identity as scientist), which predicted a positive outcome of entering a STEM career (Chemers et al., 2011). This study supported this claim through direct observation of two students from differing cultural and academic backgrounds, where one student demonstrated a stronger sense of these components more than the other. Figure 5 demonstrates the relationship among all components, where (A) flows into (C) and (D) resulting in the final outcome of a commitment to a STEM career, with (B) playing into all of these factors.

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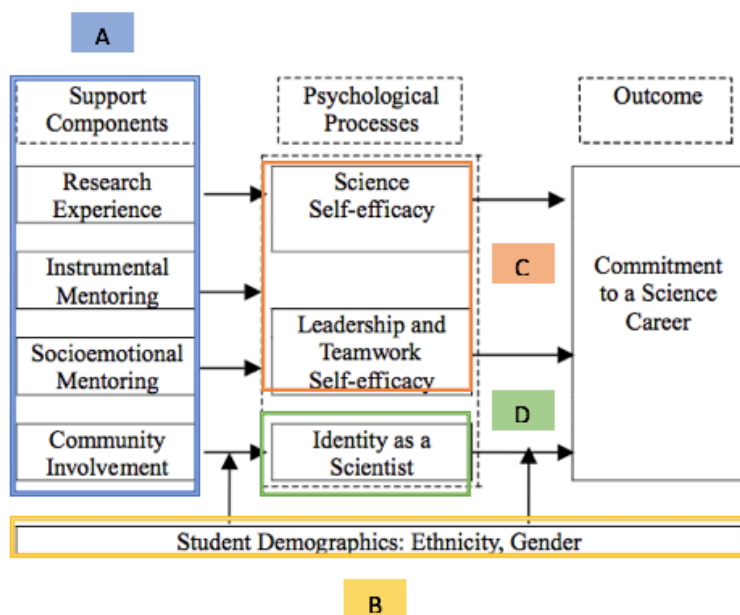


Figure 5. Flow model divided by component or factor. (A) includes the Support Components such as Research Experience, Instrumental Mentoring, Socioemotional Mentoring, and Community Involvement. (B) includes Student Demographics like Gender, Ethnicity, Race, etc. (C) involves part of the Psychological Processes including Science Self-efficacy and Leadership and Teamwork Self-efficacy. (D) includes the remaining Psychological Processes which is Identity as a Scientist. All of these flow into the Outcome of a Commitment to a Science Career. Adapted from Chemers et al., 2011.

Connor's Flow Model Application. Connor's scientific identity formation seemed to have hardly evolved, if it evolved at all. He came into the class with a very strong STEM background due to previous classes and programs he was a part of throughout middle and high school. Connor had access to a variety of support components (A) since he was so heavily involved with a variety of STEM programs. The experience he was able to receive through mentorship and guidance developed already, creating a flow into self-efficacy (C) and identity as a scientist (D). Self-efficacy (C) was developed through the variety of opportunities Connor was able to receive and a wide scope of fields and careers he was exposed to throughout his STEM experiences. Since Connor had support from his teachers and instructors, his self-efficacy was developed. From the start of the bioscience class, he aimed towards entering medical school to

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become an optometrist or ophthalmologist. Toward the end of the class, he focused mostly on going into either field, and created a plan of action in order to accomplish this goal. Support components (A), self-efficacy (C), and identity as a scientist (D) were influenced by the student demographics (B), whether Connor explicitly understood this or not. He did not feel his gender or culture played a role, yet his religious influence did. Religion is still an integral part of culture, so Connor was blindly influenced by this factor. Since support components (A), self-efficacy (C), and identity as a scientist (D) were already established, Connor's outcome remained the same.

Milan's Flow Model Application. Milan differed from Connor in the fact he entered the class with low self-efficacy and identity as a scientist. Milan had neither support components (A) nor self-efficacy (C) and identity as a scientist (D). Since Milan was not exposed to the support components (A) nor had he any interaction with the support components (A), Milan's scientific identity reflected his lack of knowledge of STEM fields and careers. Once Milan entered the bioscience class, he received and interacted with the support components (A) daily. As he continued to interact with the support components (A), self-efficacy (C) started to develop consistently. As Milan was interacting with STEM professionals, gaining research experience, and developing relationships with his instructors through the bioscience class, Milan was experiencing a vast amount of opportunities to view science in a much broader view than what he previously had thought. He gained access to resources he had no access to before, allowing him to show his leadership self-efficacy by applying for internships and running for HOSA president. As he was involved with more research in the bioscience class, along with interacting with STEM professionals, Milan started gaining a sense of identity as a scientist (D). The more connected with professionals and research he felt, and the more opportunities he was given

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through the bioscience class, the stronger self-efficacy (C) and identity as a scientist (D) were developing, which then lead into a stronger commitment to STEM. Whereas Milan only had one type of STEM career in mind, he was gaining more knowledge about other STEM careers, which allowed him to think about a variety of STEM careers, even ones that required extremely advanced degrees.

Student demographics (B) were a strong influence in Milan's scientific identity formation, as it had played a major role in his decisions to enter a STEM career. Milan, in both interviews, stated his desire to enter a career as a paramedic in order to help his home, a Navajo reservation. From the beginning he had this desire to help his people, which played into the support components (A), where he was gaining more experience in order to fulfill this goal. Once he interacted with support components (A), self-efficacy (C), and identity as a scientist (D), student demographics (B) was very much an influence for him. This allowed him to see the endless possibilities to help his home even more than he originally thought.

Implications

The goal of the bioscience class was to establish mentoring relationships, create community partnerships, allow students to deal with research, and give students a platform to increase self-efficacy. Through the data collection and interpretation of Connor, I was able to see how someone from a strong scientific background maintained self-efficacy whereas with Milan, I was able to see this affect his decisions to enter an even more advanced STEM career with the help of this class and influence of his cultural identity. This research demonstrated one way in which Native American students like Milan can succeed in science, and develop his self-efficacy in order to enter a STEM career. With this in mind, the application of the flow model is not constrained to afterschool science classes. Any science class can develop students' scientific

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identity through giving students the opportunities such as research experience, networking students with STEM professionals, and creating a variety of resources students can pursue. Milan was told about internships, summer programs, and conferences, which lead him to apply himself, and developed his self-efficacy due to the bioscience class creating an opportunity for him to do so, as long as the teacher or school provides this for the students.

Limitations

This research examined two male students from different backgrounds. I am not able to make a generalization for all students, particularly female students, especially since there is a lack of women in STEM careers. There were also time constraints on the research, since it was only a yearlong project. Another limitation was that teachers from student's high schools were unwilling to participate, therefore resulting in only one instructor performing two interviews for the two students. Students within the class were also willing to be at the class every day after school for three hours. These students wanted to go into STEM, so the niche of students were already either heavily involved in STEM or willing to be involved. Further research would have to take this into consideration, and modified for true generalizations of scientific identity.

Further Research

For future research, I would revise the interview protocols in order to refine themes. To expose patterns within interview answers, questions can be used to ask more guided questions to particular themes yet still keeping the interviews semi-structured. Teacher interviews should be expanded to high school teachers from previous classes, and more than one instructor should be used.

There was a lack of rigorous questioning about previous STEM experiences. Understanding what exactly students have experienced in STEM, if they felt pressured to

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complete STEM classes, and how confident they felt in STEM coming into the bioscience class. Having a strong STEM background, as seen in Connor's narrative, influenced the development of his scientific identity. Creating a protocol that could elaborate strongly on STEM background could contribute even more to the research.

Not only should future research focus on past experiences in STEM, but having a follow-up on these students either after the class, or after college. Understanding how the class impacted students after leaving could be beneficial to creating a narrative revolved around student success in STEM.

Conclusion

The case study identified two students from differing cultural backgrounds and created a narrative involving scientific identity development and STEM careers. This research added to the literature, specifically contributing to scientific identity in underrepresented students through a PBL bioscience class. Influential factors such as cultural or academic backgrounds seemed to play a role in determining career goals, however, with the exposure to science, mentorship, and community partnerships, self-efficacy either grew or was maintained, depending on background. Research previously done, backed by figure 2, is supported by this research, and the contribution to this literature is beneficial to all students (Chemers et al., 2011).

The PBL bioscience class, very much unlike a traditional class, was created to allow students the opportunity to be in charge of learning. Through interactions with research experience in science, students were able to take phenomenon and relate them to real world situations. Not only does this particular type of classroom set up allow students to gain a deeper understanding of the phenomenon, but it allows students the view themselves as scientists, working toward an attainable solution to a local problem.

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Community partnerships, such as doctors and medical organizations, were able to pose students with local problems. This allowed students the opportunity to interact with scientists, generating a network for students and professionals in STEM fields to work towards a common solution. These community partnerships shaped student thinking, allowing students to feel as though they are scientists as well with a place in the community.

Experience, mentorship, and community involvement leads to growth of self-efficacy, giving students the opportunity to cultivate a scientific identity. Findings supported this in Milan, an underrepresented student within the bioscience class, who entered the class wanting to become a paramedic, but when faced with these factors, decided to be an orthopedic surgeon. Milan's cultural background played a role in his decision making from the beginning, and remained the same ties to his community as before. Compared to Connor, a Caucasian student in the bioscience class, who had a strong STEM background, felt no ties to his cultural background, and was already determined to enter a STEM field. Instead of Connor's self-efficacy shifting dramatically, Connor seemed to maintain self-efficacy, possibly allowing him to narrow down which area of science he wanted to pursue.

Further research into this topic can only yield productive outcomes for underrepresented students. Identifying ways to improve underrepresented presence in STEM fields is crucial, and this research has contributed to the literature in this area. Creating environments such as a PBL bioscience class for students to develop their scientific identity is imperative to commitment in STEM fields with the help of mentors and community partnerships. Collaboration amongst all these factors can only benefit student identity, and most essentially, student success.

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Appendix A

Quote Examples for Semi-Structured Interviews

Main Codes	Subcodes	Example Quote
Educational and Career Planning	Current educational experience	“I'm taking chemistry right now . . . I feel very positive about it. It's a lot of math and I like math.”
	Perception of school or school value	“I love learning and stuff. And of course you run into those teachers you don't like but it's just the whole experience of learning. I did a lot of leadership courses like MITE-E and CIT so just kind of that engineering and science”
	Educational aspirations	“My end goal is to go to medical school, so whether that is through community college then university or just maybe getting a scholarship that goes right through but I've been researching that.”
	Career aspirations	“Yeah, I definitely want to go down the medical field just kind of like past family stuff. My mom is in the dentistry stuff so that really interests me and I'm also looking into optometry or ophthalmology or something like that so, yeah.”
	Non-STEM exploration	“The only programs I have done is wrestling, football, and marching band, that's pretty much it.”
	STEM exploration	“I was either going to do, my first thought before joining this class was EMS class at [local community college], but I was kinda late for that so I took this [bioscience class] instead.”
	Lack of exploration	“I don't think it was offered really.”

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		<p>There was a lot of after school stuff like music stuff, but I haven't really seen anything.”</p>
	Positive future outcomes*	<p>“Right after high school I want to become a paramedic so I am trying to exceed my education so I can get some volunteer hours and take some EMT courses in order to get my certifications and skills and CPR and hopefully get accepted.”</p>
	Negative future outcomes*	<p>“I know the only way you're successful is through relationships with other people which I think would be really hard for me. I think that relationship could also be negative because if you did something wrong then that could affect you getting a job somewhere else because you know it just spreads to everyone.”</p>
Identifying Connections to Future Work/Goals	School and work/goals	<p>“I know the amount of schooling, since it's medical school and undergrad and residency, so it's like imagining all the school years I have down now and doing that all over again which seems very intense so who knows where I will be or what mindset I will have.”</p>
	Personal interests and work/goal	<p>“I am very challenging and competitive. I like to get work done. I actually like to help people so I see that's still with me. And communicating a lot, joking around, so I think I will still be there.”</p>
STEM Experiences	Attitudes toward STEM courses and careers	<p>“I took biology . . . I wasn't into kinda organisms and lives . . . I think it was just kinda the subject. The teacher was cool.</p>

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	Personal experiences*	“So I went into my, like I said, middle school which is a thing offered at (local MS) and it is Middle Institute of Technology and Engineering (MIT-E) so, yeah, perfect for that. It's just like advanced years so like we were always a year or two above other students, um, just with math levels, and we had the separate engineering, and science was above everyone else too.”
	Family experiences*	“I guess they are both in medical stuff. My dad works at the hospital, he's the trauma director and my mom is a dental hygienist so they are both really big on science and stuff like that and push that.”
	Peer experiences*	“We talk about how we can improve [STEM] things like in everyday stuff. Like how we disagree in one way and how we could come up with a better system-related approach.”
Bioscience Course Reactions	Positive bioscience course reactions*	“I really like this class because of the teachers because I got to know them really well.”
	Negative bioscience course reactions*	“I think a more rigorous schedule but shortened time because it is a lot of time everyday kind of seems like it could be squished together to shorten it. I know we are learning all this information and stuff but I think it could be all be pushed into a tighter [schedule]. We are all excelled students so I think we will all be able to catch up and stick with it.”
	Neutral bioscience course reactions	N/A
	Impact of Bioscience course	“I guess getting me out there into the public view, because once I started

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		<p>taking this class, a lot of people starting knowing [what] I was doing more. A lot of people started noticing that I was doing more rather than just doing sports.”</p>
	<p>Increase in competence/knowledge in STEM topics</p>	<p>“We just did staining for bacteria and stuff, and that was super cool. I've never done anything like that. Um, and just the research paper, and the amount of work we go into about epidemiology and how it all like connects into the community and stuff is really cool.”</p>
	<p>Increase in motivation to explore STEM careers and topics</p>	<p>“Because I got elected as a president for [HOSA] I was kinda happy about that, I got elected again for being a delegate of Arizona in Boston over the summer for representing us, and kinda seeing how much is done, going to this class helps me get out there more.”</p>
<p>Impact of Student's Identity</p>	<p>Ethnicity</p>	<p>N/A</p>
	<p>Impact of ethnicity on career</p>	<p>N/A</p>
	<p>Impact of ethnicity on school experiences</p>	<p>N/A</p>
	<p>Active involvement or sustenance due to ethnicity</p>	<p>N/A</p>
	<p>Race</p>	<p>“I identify myself as a Native American.”</p>
	<p>Impact of race on career</p>	<p>N/A</p>
	<p>Impact of race on school experiences</p>	<p>“My teachers know that they, they don't really take it like I should be specially treated, they know that I should be treated like everybody else.”</p>
	<p>Active involvement or sustenance due to race</p>	<p>“Not really cultural beliefs but like from my culture and the areas there are few medical facilities and medical health care providers out</p>

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	there, so maybe I can go back out there and help them out.”
Gender	“Well I only have two older brothers, so I really haven't been able to see that approach differently let's say if I had a sister so I can't really compare it to anything.”
Impact of gender on career	“I think optometry is more led by females. It's not too big, it's like a 73% [female] dominance. So which I am definitely more interested in optometry than dentistry which dentistry is more male occupied. So I don't really think I will have a problem going into a female dominated field.”
Resources	“Um, friends, family, they are always there to help encourage me all the time.”
Family resources	“They're just really astonished with how much I have done cause both of them haven't graduated high school and they try their best to help me and they're just really surprised how much I have in me and how much potential I have for the future.”
Peer resources	“We try to help each other out like in what to do. We try to stay together so we can stick together through school.”
Educational resources	“Yeah I had a counselor my first three years of high school. She was really helpful and we kinda just went through pretty much every science career and talked about it and how you know it would relate to me.”
Community/societal resources	“I kind of talk to old friends, and they are able to ask other people if they can help me pay for my trip out

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		there. They are kind of all rooting for me because they know me as a golden boy.”
	Barriers/unsupportive influences	“Just some minor [situations], I injured myself in football and I don't know if that could hold me back when I do paramedic.”
	Barriers/unsupportive influences from self	N/A
	Barriers/unsupportive influences from family	N/A
	Barriers/unsupportive influences from peers	“Kind of, not letting what others do like drop out in the middle of the semester influence my accomplishments and stuff, and I think it will pay off in the future with like required credits in college.”
	Educational barriers/unsupportive influences	“I think it all comes down to me and my motivation, um, because even if the teacher is not that good I still have resources online and stuff to learn.”
	Barriers/unsupportive influences from the community/society	N/A
	Logistical barriers/unsupportive influences	“Um, probably just money I think which is an issue for everyone. Um, just kind of looking for those opportunities to get through the door and not having to take out a bunch of loans, be in debt for the rest of your life.”
	Religion	“So cultural, I guess not so much cultural, but religion has definitely shaped you know I want to be able to help people and to improve their lives.”
Perceptions of Self as Student	Self-Confidence	“I definitely do well in school, always have.”

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Self-Knowledge	“I think it's, I feel pretty skilled. Math and science are my strongest so I've always been in higher programs and stuff.”
Self as Student	“I am really awful at attendance. That's probably my worst quality/trait. Just cause, I don't know, just finding that motivation to get up and go in the morning and make it on time.”

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Appendix B Science Attitudes and Motivation (SAM) Instrument

Instructions: Select one level of agreement for each statement to indicate how you feel. For each statement, circle the number that best describes what you think about these statements.

For each statement, draw a circle around

- 1 if you *Strongly Disagree* with the statement.
- 2 if you *Disagree* with the statement.
- 3 if you *Agree with the statement*.
- 4 if you *Strongly Agree* with the statement.

Part 1

	<i>Strongly Disagree</i>	<i>Disagree</i>	<i>Agree</i>	<i>Strongly Agree</i>
1. I am sure of myself when I do science.	1	2	3	4
2. I think I could do Advanced Placement (AP) science.	1	2	3	4
3. I am sure of my ability to pursue a career in science.	1	2	3	4
4. Learning science requires special abilities that only some people possess.	1	2	3	4
5. I can draw upon a wide variety of scientific techniques to solve a particular problem.	1	2	3	4
6. Science is hard for me.	1	2	3	4
7. If I am faced with a new scientific problem, I can cope with it because I have a good background in science.	1	2	3	4
8. Most subjects I can handle, but I just cannot do a good job with science.	1	2	3	4
9. I get good grades in science.	1	2	3	4
10. I do not attempt to work a scientific problem without referring to the textbook or class notes.	1	2	3	4

Continued on next page...

Part 2

	<i>Strongly Disagree</i>	<i>Disagree</i>	<i>Agree</i>	<i>Strongly Agree</i>
11. I like science.	1	2	3	4
12. Males are naturally better than females in science.	1	2	3	4
13. Science is dull and boring.	1	2	3	4
14. Teaching science requires good knowledge of the content material.	1	2	3	4
15. I would have more faith in a science problem solved by a man than a woman.	1	2	3	4
16. Science is an important life skill.	1	2	3	4

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17. I am not the type of person to do well in science.	1	2	3	4
18. I enjoy being in science class more than any class in school.	1	2	3	4
19. Studying science is just as necessary for women as it is men.	1	2	3	4

Part 3

	<i>Strongly Disagree</i>	<i>Disagree</i>	<i>Agree</i>	<i>Strongly Agree</i>
20. My teachers encourage me to do well in science.	1	2	3	4
21. Knowing science will help me earn a living.	1	2	3	4
22. I would like to avoid science in college.	1	2	3	4
23. I see science as something I will not use very often when I get out of high school.	1	2	3	4
24. My teachers encourage me to take as many courses as I can in science.	1	2	3	4
25. Doing well in science is important for my future.	1	2	3	4
26. My teachers think I am the kind of person who could do well in science.	1	2	3	4
27. High-school science courses will be very helpful to me no matter what I decide to study in future.	1	2	3	4
28. I plan to take more than the required number of science courses.	1	2	3	4

SCIENTIFIC IDENTITY AND INTEREST

Appendix C

Career Interest Questionnaire (CIQ)

Name: _____

Date: _____

Career Interest Questionnaire

This survey contains 3 brief parts. Read each statement and then mark the circle that best shows how you feel.

--	--

Gender: ① Male ② Female

Part 1

Instructions: Select one level of agreement for each statement to indicate how you feel. SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree

	SD	D	U	A	SA
1. I would like to have a career in science.	①	②	③	④	⑤
2. My family is interested in the science courses I take.	①	②	③	④	⑤
3. I would enjoy a career in science.	①	②	③	④	⑤
4. My family has encouraged me to study science.	①	②	③	④	⑤

Part 2

	SD	D	U	A	SA
5. I will make it into a good college and major in an area needed for a career in science.	①	②	③	④	⑤
6. I will graduate with a college degree in a major area needed for a career in science.	①	②	③	④	⑤
7. I will have a successful professional career and make substantial scientific contributions.	①	②	③	④	⑤
8. I will get a job in a science-related area.	①	②	③	④	⑤
9. Some day when I tell others about my career, they will respect me for doing scientific work.	①	②	③	④	⑤

Part 3

	SD	D	U	A	SA
10. A career in science would enable me to work with others in meaningful ways.	①	②	③	④	⑤
11. Scientists make a meaningful difference in the world.	①	②	③	④	⑤
12. Having a career in science would be challenging.	①	②	③	④	⑤

Thanks! CIQ Ver. 1.0 3/2009, by G. Knezek & R. Christensen. Adapted from Bowdich (2009) and used by permission.

Appendix D

STEM Semantics Survey

STEM Semantics Survey		Gender: M / F
<p>This five-part questionnaire is designed to assess your perceptions of scientific disciplines. It should require about 5 minutes of your time. Usually it is best to respond with your first impression, without giving a question much thought. Your answers will remain confidential.</p>		
<p>ID: _____ School: _____</p>	<p>Use the assigned ID or the year and day of your birthday (ex: 9925 if born on the 25th day of any month in 1999).</p>	
<p>Instructions: Choose one circle between each adjective pair to indicate how you feel about the object.</p>		
<p>To me, SCIENCE is:</p>		
1.	fascinating	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		mundane
2.	appealing	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		unappealing
3.	exciting	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		unexciting
4.	means nothing	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		means a lot
5.	boring	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		interesting
<p>To me, MATH is:</p>		
1.	boring	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		interesting
2.	appealing	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		unappealing
3.	fascinating	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		mundane
4.	exciting	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		unexciting
5.	means nothing	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		means a lot
<p>To me, ENGINEERING is:</p>		
1.	appealing	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		unappealing
2.	fascinating	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		mundane
3.	means nothing	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		means a lot
4.	exciting	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		unexciting
5.	boring	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		interesting
<p>To me, TECHNOLOGY is:</p>		
1.	appealing	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		unappealing
2.	means nothing	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		means a lot
3.	boring	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		interesting
4.	exciting	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		unexciting
5.	fascinating	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		mundane
<p>To me, a CAREER in science, technology, engineering, or mathematics (is):</p>		
1.	means nothing	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		means a lot
2.	boring	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		interesting
3.	exciting	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		unexciting
4.	fascinating	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		mundane
5.	appealing	<input type="radio"/> ① <input type="radio"/> ② <input type="radio"/> ③ <input type="radio"/> ④ <input type="radio"/> ⑤ <input type="radio"/> ⑥ <input type="radio"/> ⑦
		unappealing
<p>Thank you for your time. STEM v. 1.0 by G. Knezek & R. Christensen 4/2008</p>		

Figure 1. STEM Semantics Survey

Appendix E

Student Interview Protocol

Time Interview Started: _____

Read to Interviewee: I am going to ask you a series of questions. Please answer the questions to the best of your ability; there are no right or wrong answers.

Please be sure to indicate the student # and first pseudonym at the beginning of the recording.

Part I: Post-high school goals

1. A lot of students have some idea about what they would like to do after high school. Do you have some ideas of what you'd like to do after you graduate from high school?
If unclear, use prompt: For example, some students want to attend college, some want to join the military, and some students want to get a job right away.
2. What are your career goals at this point?
Possible Follow-up Prompts:
 - i. *Please specify the job you would most like to have after you finish your education.*
 - ii. *If you cannot name the job, perhaps you can tell us about the field that you are interested in (e.g., I am interested in a health career, but I am not sure which job).*
3. If you plan to go to college, what type of courses/classes do you think you will be taking?
 - i. What do you think your major will be? (If the student does not know what a major is, you can elaborate as follows: the area that you will focus on in college)?
4. If you could do whatever you wanted for a career, regardless of the preparation required or talents, what would you do?
5. What kinds of events, situations, and people might prevent you or others you know from reaching their/your goals?
6. What do you think will help you reach your goals?

Part II: Description of self as student.

7. Can you tell me a little bit about yourself as a student?
Prompts include attendance and class participation, how well you do in school, general interest in and motivation in school.
8. What do you think helps you the most to do well in school?
9. What is the connection, if any, between how you are as a student now and your life in the future?
Prompt: do you think there is a connection? Please elaborate.

Part III: Reactions to STEM courses and experiences.

10. What has your experience been in school with courses/classes in science, technology, engineering and math (STEM)?
Please let the student know that we will call this area STEM at this point.
11. What did you like and not like about these courses/classes?
12. How skilled do you feel in your STEM classes? *Please elaborate.*
13. How interested are you in exploring or pursuing a STEM career in the future? *Please elaborate.*

SCIENTIFIC IDENTITY AND INTEREST

14. Have you explored any career interests in STEM fields in the past beyond this bioscience course?

Please let us know which STEM areas you have explored.

- a. If you have explored STEM fields, what prompted you to do so?
- b. If you have not explored STEM fields, is there anything that has kept you from considering these fields further?

Part IV: Social support and relational influences.

15. What have you learned from your teachers in high school (not the ITEST program) about STEM courses and fields?

- a. How do your teachers support you in school and with thinking about careers?

16. Also, what have you learned from your teachers/counselors about STEM courses and fields?

17. What sort of conversations do you have with your parents or guardians about your future education and career plans?

- a. How do they help you think about future careers?
- b. What work do your parents do for a living?
- c. Are any of your family members involved in a STEM-related career? What type of work do they do?

18. Are any of your family members currently in or was in the past enrolled in college? Where were they enrolled? What did they study?

19. How do your parents or guardians feel about STEM fields in general? To what extent do they talk about science and technology at home?

20. How have your parents or guardians talked about STEM courses and fields in your conversations with them?

21. What sort of conversations do you have with your friends on STEM-related issues?

Part V: Gender, race, and ethnicity and stem exploration.

22. To what extent do your family, friends and people in your community support your educational and career plans? (If not, what would they like to see you do?)

23. How do you think your family's expectations about your future plans are shaped by the fact that you are a woman/man?

24. How do you think your gender influences your interests and what you believe you can do in the future?

25. Counselors and teachers have become much more aware of how important it is to understand the cultural background of each student. Please tell us about your cultural, ethnic, and racial background. How do you identify yourself in terms of race and ethnicity?

26. In your opinion, how have your cultural beliefs influenced your career interests and expectations for what you can accomplish in the future?

- a. What are your family and community's expectations about what you are going to do in the future as a person from (Insert ethnicity) background?

Time ended: _____

SCIENTIFIC IDENTITY AND INTEREST

Student Post-Interview Protocol

Time Interview Started: _____

Read to Interviewee: I am going to ask you a series of questions. Please answer the questions to the best of your ability; there are no right or wrong answers. Your name will not be used and your identity will be kept confidential. Is it all right to record this interview?

Please be sure to indicate the student # and first pseudonym at the beginning of the recording.

Part 1: Bioscience Course

1. You are taking the bioscience class this year. Tell me a little about what you have liked about the class? *If clarification is needed, use prompt: What about lab activities, field trips, guest speakers, projects? What have you like about those parts of the class?*
2. What is particularly interesting to you about the class?
3. Elaborate on the guest speakers, field trips, and projects. What did you like/not like? What would you like to do that you didn't have an opportunity to do?
4. What is the most satisfying accomplishment for you in taking this class?
5. Describe any recommendations for the course designers and instructors for next year's class. How can we make this class better for students? What would you change? What would you add?
6. Is there anything else that I didn't ask about the class that you would like to add?

Part 2: Post-high school goals

1. A lot of students have some idea about what they would like to do after high school. Do you have some ideas of what you'd like to do after you graduate from high school?
If unclear, use prompt: For example, some students want to attend college, some want to join the military, and some students want to get a job right away.
2. **What are your career goals at this point?**
Possible Follow-up Prompts:
 1. *Please specify the job you would most like to have after you finish your education.*
 2. *If you cannot name the job, perhaps you can tell us about the field that you are interested in (e.g., I am interested in a health career, but I am not sure which job).*
3. **If you plan to go to college**, what type of courses/classes do you think you will be taking?
 1. What do you think your major will be? (If the student does not know what a major is, you can elaborate as follows: the area that you will focus on in college)?
4. **If you could do whatever you wanted for a career, regardless of the preparation required or talents, what would you do?**
5. **What kinds of events, situations, and people might prevent you or others you know from reaching their/your goals?**
6. **What do you think will help you reach your goals?**

Part 3: Description of self as student.

7. Can you tell me a little bit about yourself as a student?

SCIENTIFIC IDENTITY AND INTEREST

Prompts include attendance and class participation, how well you do in school, general interest in and motivation in school.

- 8. What do you think helps you the most to do well in school?**
- 9. What is the connection, if any, between how you are as a student now and your life in the future? Prompt: do you think there is a connection? Please elaborate.**

Part 4: Reactions to STEM courses and experiences.

(Ask only if prompts or elaboration are needed)

10. What has your experience been in school with courses/classes in science, technology, engineering and math (STEM)? *Please let the student know that we will call this area STEM at this point.*
11. What did you like and not like about these courses/classes?
- 12. How skilled do you feel in your STEM classes? Please elaborate.**
- 13. How interested are you in exploring or pursuing a STEM career in the future? Please elaborate.**
- 14. Have you explored any career interests in STEM fields in the past beyond this bioscience course?**
Please let us know which STEM areas you have explored.
 - i. If you have explored STEM fields, what prompted you to do so?
 - ii. If you have not explored STEM fields, is there anything that has kept you from considering these fields further?

Part 5: Social support and relational influences.

15. What have you learned from your teachers in high school (not the ITEST program) about STEM courses and fields?
 - i. How do your teachers support you in school and with thinking about careers?
16. Also, what have you learned from your teachers/counselors about STEM courses and fields?
- 17. What sort of conversations do you have with your parents or guardians about your future education and career plans?**
 - i. How do they help you think about future careers?**
 - ii. What work do your parents do for a living?**
 - iii. Are any of your family members involved in a STEM-related career? What type of work do they do?**
18. Are any of your family members currently in or was in the past enrolled in college? Where were they enrolled? What did they study?
19. How do your parents or guardians feel about STEM fields in general? To what extent do they talk about science and technology at home?
- 20. How have your parents or guardians talked about STEM courses and fields in your conversations with them?**
- 21. What sort of conversations do you have with your friends on STEM-related issues?**

Part 6: Gender, race, and ethnicity and stem exploration.

- 22. To what extent do your family, friends and people in your community support your**

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educational and career plans? (If not, what would they like to see you do?)

23. How do you think your family's expectations about your future plans are shaped by the fact that you are a woman/man?
24. How do you think your gender influences your interests and what you believe you can do in the future?
25. Counselors and teachers have become much more aware of how important it is to understand the cultural background of each student. Please tell us about your cultural, ethnic, and racial background. How do you identify yourself in terms of race and ethnicity?
26. **In your opinion, how have your cultural beliefs influenced your career interests and expectations for what you can accomplish in the future?**
 - i. **What are your family and community's expectations about what you are going to do in the future as a person from (Insert ethnicity) background?**

Time ended: _____

Appendix F

Parent Interview Protocol

Time Interview Started: _____

Phone? ___ *In-Person?* ___

Please read to interviewee: Thank you for your participation in this research and interview. Today I will be asking you some questions and I want you to answer to the best of your ability. There are no right or wrong answers. Did you have any questions for me before we begin?

Please indicate student number and parent pseudonym before beginning the interview.

1. What do you do for a living? What does your spouse do for a living?
2. What is your highest degree?
3. What are your child's hobbies?
4. Does your child talk about school or this bioscience class?
5. Does your child talk about future plans with you?
6. Does your child research fields of interest regularly at home?
7. Is your child well organized or plan ahead?
8. Would you consider your child a 'science person'?
9. How do you feel about STEM fields and is that a career choice you want for your child?
10. Is your child the only child? If not, are your other children in school or in a STEM related field?
11. Do you find yourself pushing your child more towards a STEM career?

Appendix G

Friend Interview Protocol

Time Interview Started: _____

Phone? ___ *In-Person?* ___

Please read to interviewee: Thank you for your participation in this research and interview. Today I will be asking you some questions and I want you to answer to the best of your ability. There are no right or wrong answers. Did you have any questions for me before we begin?

Please indicate student number and friend pseudonym before beginning the interview.

1. What would you like to do after high school?
2. How do you know (student) and how long have you known him/her for?
3. How often do you and your friend hang out?
4. Do you hang outside of school?
5. Are there any other programs you have been in together?
6. What do you and your friend usually talk about when you hang out?
7. Do you go to many school related events together?
8. Does your friend initiate conversations about science related issues?
9. How often do you talk about science related things with each other? Is it frequent or just occasionally?
10. Would you identify your friend as a “science person”?
11. From the time you have known your friend, how have you seen him/her grow in interest for STEM careers?
12. Has this bioscience class allowed him to narrow down what he wants to do?
13. What other ways has this class affected his way of looking at science?

Appendix H

Teacher Interview Protocol

Time Interview Started: _____

Phone? ___ *In-Person?* ___

Please read to interviewee: Thank you for your participation in this research and interview. Today I will be asking you some questions and I want you to answer to the best of your ability. There are no right or wrong answers. Did you have any questions for me before we begin?

Please indicate student number and teacher pseudonym before beginning the interview.

1. What subjects & grades have you taught?
2. How long have you been teaching for?
3. What has been the best part of teaching science for you?
4. Does this student volunteer in class to help others?
5. Do they interact with peers?
6. Do they offer to answer questions?
 - a. Are they developed thoughts or on a whim?
7. Does your student talk about his/her future with you?
8. How well does he/she do in science class?
9. Does your student approach you about STEM careers?
10. Have you maintained communication with this student since he/she has left this class? If this student is still in your class, do you think you will remain in contact with this student after he/she leaves your class?
11. Were you able to see your student grow in science knowledge and confidence throughout your class?
 - a. Has his STEM career been influenced by class?