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Increasing Student Interest Through the Explicit Teaching about Women and BIPOC Scientists in the Forensic Science Curriculum

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Master of Arts in Teaching Leadership

By

Melissa Shaw Luna

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This action research project, written under the direction of the candidate's master's project advisory committee and approved by members of the committee, has been presented to and accepted by the faculty of the Kalmanovitz School of Education, in partial fulfillment of the requirements for the Master of Arts in Teaching Leadership degree.

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Abstract

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By

Melissa Shaw Luna

Master of Arts in Teaching Leadership

Saint Mary's College of California, 2022

Karl Meyer, Ed.D, Research Advisor

The purpose of this action research was to see how the addition of explicit teaching and learning about women and BIPOC STEM professionals in the forensic science curriculum may increase junior and senior student's interest in a STEM career or major. The sample size of 120 junior and senior high school students enrolled in four sections of forensic science was used in this study. A mixed-methods research design was used to analyze data. An increase in student interest was found from the beginning of the course to the end of the research study. Students identified both experiential learning using hands-on activities and culturally responsive teaching, using women and BIPOC examples as factors that increased their overall interest levels.

Dedication

This is dedicated to all my students that have helped shape me as a teacher leader. Thank you for your hard work, honest feedback, effort, and your joy of learning that I have had the opportunity to experience as your teacher.

Acknowledgements

Teaching during a pandemic was the most challenging time in my professional career, until I decided to pursue a master's degree and became a student during the pandemic. The 2022 MATL cohort supported, encouraged, and lifted each other up during this time so that we were able to complete our degrees.

I would like to thank my research advisor Dr. Karl Meyer for his encouragement, support and editing superpowers. I would also like to thank my faculty advisor, Dr. Heidimarie Rambo for her thought provoking questions, no-nonsense feedback, for holding the bar high, and challenging me to meet it throughout this process. Thank you to my instructor Dr. Monique Lane for expanding my thinking, my music library, my vocabulary, and my definition of what a teacher leader is. I need to thank my colleagues at my school site for all their advice and support; especially Sarah Musumeci and Renee McCormick. Finally, I would like to thank my cohort bestie Chelsey Hernandez Miller, who I recognized as a kindred spirit on our first day of class, for her late-night Zoom sessions, advice, sense of humor, and her hard work. I would not have been able to do this without the guidance, support and help that you all provided over this past year. Thank you.

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Chapter I

Introduction

The 2020 election was historic because a woman finally broke the glass ceiling at our highest level of government. Vice President Kamala Harris, a BIPOC (Black, Indigenous, People of Color) woman, opened the door and inspired millions of young girls to pursue their dreams. However, the year 2020 has also brought the United States the continuing challenge of fighting the COVID-19 virus. The nightly news reported record numbers of women that have had to make the difficult decision to stay home to care for their children, leave their jobs and struggle to find child-care options, the gains in the workforce that were once made have all but disappeared. Congresswoman Madeleine Dean of Pennsylvania recently stated that nearly three million women left the workforce during the pandemic. The traditional male-female roles inside of the home have been backsliding during this pandemic, and it further highlights the differences in earning potential and job opportunities for women in the workforce. The technology industry is an example of this inequity, as the United States continues to see a decrease in the number of women enrolling in science and technology majors in college (Gokhale et al., 2015). Yet, the need for highly skilled workers, especially those with science and technology backgrounds, is increasing; and the qualified pool of college-graduates is shrinking. Educators on the front lines have witnessed this, researchers invested in the advancement of STEM (Science, Technology, Engineering, and Math) disciplines have stated that the priority should be increasing the strength of the STEM pipeline with highly-qualified workers (Griffith, 2010). This has led to research investigating the "leaky pipeline," the loss of woman-identified students that were once enrolled in STEM majors in college. Research conducted with female high school students has identified

a “career exposure gap,” where both female juniors and seniors have a higher aptitude than interest level when it comes to STEM majors (Kuykendall, 2022).

High school is the time in many students’ lives when they begin to contemplate and plan their futures, beginning with what they will major in when they graduate and move on to college. Selection of elective courses during their junior and senior year are critical because these classes are often a student’s first introduction to a field of interest. Teachers, college professors, guidance counselors, advisors, and other stakeholders focused on developing STEM programs have sought strategies for more effective, long-term recruitment and retention of women and BIPOC in STEM majors (Bystydzienski et al., 2015). By focusing on female-identified and BIPOC students, targeted interventions in the form of career counseling or shadowing a professional could help direct these students into STEM fields and disciplines that they may not have considered before the exposure to the field.

Educational theorist Carl Rogers (1994) developed a theory based on two types of learning: cognitive and experiential. The first type explains academic knowledge like memorizing vocabulary terms or multiplication tables and the second is applied knowledge using hands-on experiences to acquire a skill. The key difference is that experiential learning is more likely to include the needs and wants of the students (Rogers & Freiberg, 1994). Researchers interested in how students learn must find a way to incorporate hands-on learning opportunities that appeal to every student. Young children begin to see themselves as a specific gender before they enter formal schooling from a variety of sources including social media, television programs, parents, and society. By adopting an equity lens to address this inequity of opportunity, “developmental psychology theories as well as theories outlining the social construction of gender concur that as children grow up, they look to the world around them to

learn about the prominent characteristics and behaviors culturally assigned to different genders" (Riegle-Crumb & Peng, 2021, p. 511). For their birthdays, girls receive dolls, art supplies, costumes, and princess toys while boys are gifted with cars and trucks, blocks, building toys and sports equipment. The gender-specific toys are an issue as students enter their first years of schooling because children are exposed to differentiated learning based on gender as early as preschool (Gokhale et al., 2015). When these same students enter high school, the boys have had more learning opportunities using hands-on experiences in math and science classes than girls, making them more prepared for project-based, interactive laboratory experiences than their female classmates (Gokhale et al., 2015). This supports the idea that targeted interventions as early as preschool may benefit young girls as students and potentially lead to an increase in STEM majors entering college and then the workforce and addresses an inequity in the classroom between male and female students.

Statement of the Problem

I teach junior and senior high school students at a large, comprehensive high school with over 2,600 students. At the time of the study, I was entering my seventh year of teaching at this high school. I had approximately 160 students in total. There were 40 students in my two sections of AP Biology, and 120 students in the four sections of Forensic Science. The demographics of the student population for the 2021-2022 school year were as follows: 46.7%, Latinx, 27.5%, White, 9.8%, African American, 5.5%, Filipino, 5.2%, students that identify as two or more races, 3.6%, Asian, 0.4%, American Indian/Alaska Native and 0.35%, Pacific Islander. The gender breakdown in my classes during this action research period was approximately 60% students who identify as female vs. 40% that identify as male. Over the past six years, the enrollment numbers of female-identified students in my elective science classes

have been increasing. Although I have continued to see more girls choose to take these *classes*, I have not seen an increase in the number of those students who choose STEM or other Science *majors,* particularly in the forensic science field. Seventy percent of our graduating seniors go on to community college or a four-year university and while approximately 50 to 70 percent of the AP Biology students major in a STEM field in college, less than five percent of the forensic science students choose that career path.

The field of forensic science and its disciplines is huge and although I introduce dozens of careers in the field throughout the year-long course, not enough young women (including BIPOC female-identified learners) pursue it. I want to show these students examples of successful women in these jobs and careers because I believe that part of the issue is that these students often do not see themselves reflected in the sciences. The STEM fields have long been dominated by white men in positions of power and decision-making. There are students that enter college with a declared major, only to switch career paths after their first two years. This is a trend that has been identified particularly for students with a STEM major. For BIPOC students and women, research has shown that they are less likely to remain in a STEM major in college, than their White male peers (Griffith, 2010). A continual loss of women and BIPOC students during their college careers likely has a direct effect on the decreasing number of qualified STEM-trained technology workers that are needed to fill the holes in these fields.

Purpose of the Research

The most recent United States census reported that 50.8% of the U.S. population identify as women, and in the civilian labor force (percent of population age 16+ years) during the years 2015-2019, 58.3% of the country's workers were women. (U.S. Census Bureau, 2019). According to the Department of Education, from 2009 and 2018, the percentage of public-school

students who were Latinx increased from 22 to 27 percent while the percentage of students who were White decreased from 54 to 47 percent, and the percentage Black student decreased from 17 to 15 percent (U.S. Department of Education, 2021). This demographic trend is also reflected in the state of California student population, which shows that enrollment has decreased from 6.24 million students in the 2014-15 school year to 6.19 million in 2018-19. This is a decrease of approximately 0.8%. However, throughout California, the Latinx student population has increased from 53.6 percent, beginning in 2015 to 54.6 percent in 2019. Conversely, the percentage of White students has continued to decline (California Department of Education, 2019). With the decreasing population of White students, particularly young White men, STEM jobs that traditionally have been filled by this specific group are now seeing a shortage of qualified candidates.

The purpose of this study was to investigate how the addition of examples of both women and BIPOC STEM professionals into the forensic science curriculum might increase junior and senior students' interest in a science career, with a particular focus on the forensic science disciplines. I hypothesized that part of the low enrollment stemmed from these students not seeing themselves reflected in the work force or not having role models that have the same ethnic, racial and/or gender backgrounds as the students. My school site was a large, high school only district, comprised of three comprehensive high schools and two smaller, non-traditional schools. I worked at the school with the greatest racial diversity, the highest number of free and reduced lunch students, and feeder schools in six different communities. The students in the study chose to take an upper-division science elective during their junior or senior year.

My school site was racially diverse with majority Latinx and White populations. I have been intentionally recruiting young women to enroll in both my AP Biology and Forensic

Science classes for the past six years by outreach to teachers in prerequisite classes and the middle schools, by word of mouth from current students and by the visibility of my current students on campus performing various investigations that are anchored in a forensic science unit. The AP Biology students continue to show a high-level of interest in STEM majors and apply to multiple colleges with the intention of pursing a science career. Even though I have almost three times as many Forensic Science students, less than 5% of these students intend to major in any type of science when they enter college. With the increasing numbers of women and BIPOC women in the U.S. population and fewer White men, the question becomes who will fill the jobs that White men have had a monopoly on for decades?

It is possible that one of the issues preventing more students from pursuing STEM majors is that both female-identified students and BIPOC students do not see themselves reflected in the curriculum or in the job field. By deliberately bringing in specific examples of professionals in the field that accurately reflect the demographics of the incoming freshman student population, perhaps BIPOC and female-identified students and possibly more students in general will consider science as their future career. The majority (approximately 70%) of the students in my four sections of forensic science applied to and were accepted to either a community college or a four-year college or university upon graduation. These students were able to select forensic science in their junior or senior year of high school because they qualified for an upper-division elective class by completing both the required prerequisite classes and the California A-G graduation requirements. The purpose of this action research was to determine whether using women and BIPOC that accurately reflected the demographics of the participants would increase student interest and which class activities were most influential in students who reported a change in their interest level over the course of the school year.

Action Research Question

This study examined how deliberate examples of women and BIPOC scientists in the forensic science curriculum increased student's interest in pursuing a career in science. The question that this study was designed to answer was: *How will the addition of explicit teaching and learning about women and BIPOC STEM professionals in the forensic science curriculum increase junior and senior student's interest in a STEM career or major?* My hypothesis focused on the idea that part of the problem was that female-identified and BIPOC students did not see enough examples of professionals in the field that accurately reflected their race, gender, or culture. My hope was to see an increase in the number of female-identified and BIPOC students that were interested in a STEM major when they moved on to college after graduation.

Limitations

This study was conducted over a 10-week period with 120 students in four sections of forensic science, which reflected the demographics of the entire student population enrolled in forensic science for the school year. One of the limitations was time, being a full-time teacher of two advanced placement classes, four sections of forensic science, and conducting the research was a challenge in this short time frame when data were collected. This limited the amount of the participants' responses that were collected and analyzed. The time restriction resulted in only being able to collect data from eight units, and not the entire, year-long course that is normally comprised of 13-15 units in total. By not being able to collect data for the entire school year, there may have been topics in units not covered during the action research period that had a different effect on student interest than the material and curriculum found in each unit that were included in this study. This may have hindered the findings and generalizability of the action research study because there may have been units with topics or activities that generated a high-

level of interest and engagement, but they did not fall within the timeline of the study. The opposite may have also been true, and students could have been disengaged and uninterested in a unit of study that also fell outside the 10-week period when the research was conducted. Students who participated were asked to recall information from the beginning of the course and that may or may not have been accurately reported by the students. The data were collected at a large suburban high school with a diverse student body in Northern California. Students enrolled in the classes were able to select this elective and therefore demonstrated an interest in the topic because of their ability to choose classes based on interest, rather than being assigned to the class because they needed credits and classes to meet graduation requirements. These restrictions may affect the generalizability of the study to other areas of the country and to smaller high schools with a different student demographic profile. For example, students who attend high schools where the majority of the population is White, or where the classes had a higher percentage of male-identified students, may not have had the same reaction to the interventions put in place during this action research study.

Positionality of the Researcher

I am a White cisgender woman working in a racially diverse large suburban high school. Being White requires me to continually check my privilege, especially when I am working with my BIPOC students. I was able to use my educational opportunities in both high school and college to become upper-middle class after growing up in a multi-generational home in a low-income section of Boston, Massachusetts. I have prioritized making my classroom a safe space for all students and encourage all students to work together as a class to lift each other up and support each other throughout the year. The advantage I have in teaching upper-division electives to only 11th and 12th graders is that the students have chosen to take the forensic

science class, so I assume that they like science and are more than casually interested in a STEM or science major after they graduate. This assumption has proved problematic because it discounts other factors when it comes to student choice of elective classes, like scheduling, peers enrolled in the class, or a lack of information about the class itself. By using data triangulation, I hoped to mitigate these biases and my position on why the students were in my classes by collecting data specifically focused on student interest. The course is a lab-based, hands-on class that provides students with multiple opportunities to interact with the materials using both contextualized teaching and learning (CTL) and experiential learning theory to anchor instruction.

Additionally, teaching is my second career that began while I was a Registered Nurse working in San Francisco and part of my job description required me to train post-graduate nurses, medical students, and surgical interns on how to "scrub" into surgical procedures. I experienced first-hand during my two decades working in medicine the implicit bias that exists against women of child-bearing age by the men in the field. I had to watch multiple male nurses who I had trained and mentored get promotions or other special assignments because they did not take time off to have children. Eventually, I had to make a choice between getting ahead in my career or working less to spend more time with my family. This is not something that any of my male colleagues were struggling with, and it highlighted the inequity in the medical field and the biases against women, many with more experience and education than their male counterparts.

The importance of this research is clear. It is critical for the U.S. labor force to reflect the demographics of its citizens and focus on recruitment and retention of both women and BIPOC

workers to meet the increasing demand for technologically savvy workers to continue to compete on a global scale.

Definition of Terms

There are many terms used throughout this action research project that have been defined below. Some of these terms may be unfamiliar to the reader or could be misinterpreted and therefore, these definitions are provided for clarity and explain how they are used in the context of the paper.

BIPOC

Black, Indigenous, People of Color (BIPOC) is a term used to build authentic and lasting solidarity among Black, Indigenous and People of Color (Merriam-Webster, 2021).

Contextualized Teaching and Learning or CTL

Contextualized Teaching and Learning (CTL) is a strategy that engages learners and promotes improved skill development by helping teachers relate subject matter to real-world situations and experiences (Mohammadi et al., 2020).

Experiential Learning

Experiential learning is the process of learning by doing. Students engage in hands-on experiences and reflection, so they are better able to connect theories and knowledge learned in the classroom to real-work situations (Kolb, 2015).

Extant Research

Extant data collection methods include both the review of various kinds of written documents or visual materials and conduct of unobtrusive observation. (Sage, 2021).

Female-Identified/Women-Identified

Woman-identified refers to someone who identifies as a woman. It recognizes that gender is a self-identification that does not necessarily match the sex of an individual at birth. (UNI, 2021.)

Forensic Science

Forensic Science is defined as the application of scientific principles and techniques to matters of criminal justice especially as relating to the collection, examination, and analysis of physical evidence. (Merriam-Webster, 2021).

Science, Technology, Engineering and Math or STEM

The STEM acronym was introduced in 2001 by scientific administrators at the U.S. National Science Foundation (NSF). The organization previously used the acronym SMET when referring to the career fields in those disciplines or a curriculum that integrated knowledge and skills from those fields. (NSF, 2021).

Implications

Extant research clearly supports the notion that targeted interventions in high school can influence female-identified and BIPOC students' interest in the sciences as well as major choice. A review of the demographic profile of the students currently enrolled in STEM majors continues to demonstrate that science education in the United States is not focusing on the recruitment of the many diverse populations found in our country. This problem and inequity in hiring and training of Women and BIPOC students in the STEM field has contributed to the loss of qualified technology workers in the United States. There has been research and funding through many federal programs that have attempted to remediate this inequity, but it persists. The numbers of White women, African Americans, Latinx and Native Americans being trained

in STEM fields or obtaining degrees in the sciences, math and engineering is still critically low. (Bystydzienski et al., 2015). The intention of my research for my own students was two-fold. I wanted raise awareness by including more women scientists, BIPOC female-identified innovators, and examples of BIPOC STEM field practitioners to represent the diversity found inside my classroom every day and to let all the students know that the traditional "white-male-in-a-white-lab-coat stereotype" was the not the reality in modern day science labs around the world.

Additionally, I wanted to find data showing that supplemental support, in the form of career counselors, which demonstrated the idea that female-identified learners and BIPOC students in high school were the populations where targeted interventions could have influence on both their college choice and field of study. This could potentially lead to the school site or the district hiring more career counselors or guidance counselors who would be able to spend time working with this underrepresented group, to increase the enrollment of both female-identified and BIPOC students in STEM majors in college. The larger societal issue brings in both the shortage of qualified science and technology workers in the current job market and the future STEM-trained workers that the United States will need to continue to compete on the global market. With the continually changing population demographics in this country shifting from a predominantly white-male workforce to an increasingly female and BIPOC workforce, the intentional recruitment and retainment of these groups needs to occur. The problems that the world will be facing will require a global perspective and that includes every race, gender, and culture on the planet to work together for the common good.

Chapter II

Literature Review

The purpose of this study was to investigate what factors influence female-identified students and BIPOC students' interests in science or STEM majors in college, with a particular focus on the forensic science disciplines. I hypothesized that part of the low enrollment stemmed from these students not seeing themselves reflected in the workforce or not having role models that have the same ethnic, racial and/or gender backgrounds as the students enrolled in the classes. The number of female-identified and BIPOC students have increased in my elective science classes over the past several years. Although I continue to see more students that identify as female choose to take these *classes*, the number of female-identified and BIPOC students from our school who choose STEM or other Science *majors*, particularly in the forensic science field, as they move onto college has not increased. This study examined how the intentional exploration of women and BIPOC scientists in the Forensic curriculum impacted students' interest in pursuing a career in science. The question that this study was designed to answer is: *How will the addition of explicit teaching and learning about women and BIPOC STEM professionals in the forensic science curriculum increase junior and senior student's interest in a STEM career or major as measured by pre and post unit exit tickets, an observation protocol, and a college/career assignment essay?*

Overview of the Literature Review

The action research project examined the impact of learning about women and BIPOC STEM professionals on student interest in a potential STEM major or career as they transitioned from high school to either the workforce or a post-secondary institution. This chapter begins with the theoretical rationale. The work of John Dewey (1986), a leader in the United States'

progressive education movement is used to support the idea that student interest was critical to children's learning the material being taught. Much of this research was conducted throughout the 19th century by actual scientists that emphasized hands-on learning experiences inside of the classroom to increase engagement with the curriculum. Geneva Gay's (2002a) culturally responsive teaching (CRT) theory is highlighted as well, to focus on the importance of the teacher's knowledge and recognition of the unique demographic make-up of the students in their classroom. Next, the Review of Related Research contains discussions on empirical research that covers student interest and engagement, curriculum bias in science, and the use of CRT to create new curriculum that reflects the demographics inside of individual school sites. The articles included in this literature review were found through an extensive and comprehensive search of databases that include the St. Mary's College library database, Google Scholar, ERIC, and Education Full Text. The key search terms that were used include: *women, BIPOC, student interest, science majors, college majors, secondary education, gender differences in education, bias in education, STEM, experiential learning, CRT, white supremacy, patriarchy, and educating girls.*

Theoretical Rationale

There were two theories on which this action research was based. The first theory was the work of John Dewey (1998), a researcher seen as the leader of the progressive movement in education in the United States. Dewey's theory of education focused on participation in a meaningful activity while learning, that emphasized the importance of student interest in what they were being taught (Glyn, 2014). The research continued to focus on experiential inquiry inside of the classroom. Dewey and his colleagues in the progressive movement were mainly scientists that were trained of worked in the social, physical, and natural sciences. Much of their

work in educational theory developed from the advances made in both the science and technology fields during the 19th Century (Albert, 2015). Experiential learning is a teaching strategy based on providing students with opportunities to learn through experience (Kolb, 2015). The research of David Kolb (2015) (influenced by theorists John Dewey, Kurt Lewin, and Jean Piaget) on experiential learning theory relied on the idea that students can construct their own ideas on how to synthesize academic learning in the classroom in their own way by experiencing it through hands-on learning opportunities. Kolb's experiential learning theory is explained by using four stages and framing them as a cycle, a cycle that a student can enter at any stage of the learning process. The first stage is concrete learning where students are exposed to a new experience. The next stage is reflective observation where a student's past experiences frame what this new idea means to them. This is followed by abstract conceptualization where a student can synthesize what they have learned and can adjust their thinking because of the experience. The last stage is active experimentation, when the student is able to apply what they have learned to a real-world problem or issue (Kolb, 2015). This type of hands-on, project-based science curriculum has not been widely used throughout the United States, and the number of young women and BIPOPC students who have been given the opportunities to use tactile learning to interact with physical materials, is less than their White male counterparts.

The second theory that formed the theoretical rationale was Geneva Gay's (2002a) culturally responsive teaching (CRT) theory. This work had a major influence on this research, as it addressed the need for teachers to become more aware of the demographics of their classes and how to bring a wider lens that included different cultures, races, and ethnicities into the forefront of their pedagogy. It also shines a light on the continuing challenges that BIPOC students face when compared to the White classmates. Both these theories provided the

theoretical foundation for this research, and they had major influences in how the research was conducted.

Experiential Learning Theory

Experiential learning theory states that information is retained better when students are engaged in a learning process that allows them to have hands-on experiences with the content being taught. The goals of experience-based learning are more meaningful when students have a personal connection to the content (Kolb, 2015). The research question posed in this thesis looked at how intentional exposure to scientists that accurately reflected the demographics of the classroom, influenced how students saw potentially saw themselves pursing a STEM major or career. This, when partnered with a hands-on learning opportunity, might allow both female-identified and BIPOC students to bridge these two ideas. Part of the issue with the lack of representation of female-identified and BIPOC role models is the inability of science programs to offer students the opportunity to have hands-on experiences with the course content (Riegle-Crumb & Peng, 2021). By introducing women and BIPOC scientists as the actual researchers and the examples of scientists who are conducting these experiments, a new group of students will be able to make connections to the curriculum. Furthermore, a curriculum that includes women and BIPOC scientists more accurately reflects the growing number of racially, ethnically, and culturally diverse STEM professionals working today.

Kolb (2015) recognized that many educators have used the principles that Dewey put forth to further examine and expound on the importance of incorporating experiential learning theory into the science curriculum. The benefits of experiential learning are that students can immediately apply the knowledge to real-world problems and applications, students work collaboratively in teams which allows them to develop communication, collaboration and

negotiation skills, and the benefit of investigations involving hands-on experiments or activities to provide students with opportunities to practice skills needed for a future in a STEM field or career (Kolb, 2015).

Culturally Responsive Teaching

As previously stated, the opportunity for many minority students to be exposed to hands-on, project-based learning in science classes is lacking, and can begin as early as Kindergarten for students (Lareau et al., 2016). Culturally responsive teaching is defined as, "using the cultural characteristics, experiences, and perspectives of ethnically diverse students" inside of the classroom (Gay, 2002b). The work of Geneva Gay shows that when what is being taught is connected with the experiences of the students, they then become more meaningful and can result in both higher academic achievement and engagement (Gay, 2002b).

Traditionally, all students have been taught through the narrow lens of European American cultural norms. With the continuing shift of the United States population demographic away from a predominately White population, the educational needs of the other racial and ethnic learners must be considered and adopted into all aspects of K-12 education (U.S. Census Bureau, 2019). BIPOC students and female-identified students have suffered the most because of this, and as a result, fewer numbers of these populations are enrolling in STEM programs in college, as well as these demographic groups being underrepresented in the workforce (Gokhale et al., 2015). I hypothesized that one reason for the lack of women and BIPOC students enrolled in STEM programs was that they were not exposed to any role models or examples that were culturally or racially similar to them. By introducing female-identified and BIPOC students to relevant and relatable examples of actual STEM examples that they can identify with, they can begin to visualize themselves as STEM scholars.

Review of Related Research

This review of related research starts by introducing the idea of student interest and the importance of increasing it to foster a higher level of engagement, achievement, and student connectiveness to the science curriculum. Next, the curriculum bias in science is examined and its relationship to student and interest and how the lack of representation of both women and BIPOC students in STEM fields is connected to this implicit bias. This review concludes with the practice of culturally responsive teaching and how important it is for students to see themselves reflected in the content being taught inside the classroom.

Student Interest

Teachers at all levels of K -12 education are constantly challenged to find ways to increase student interest in their subject matter. The importance of student interest is clear and its role in student engagement is critical (Gay, 2002b). The link to student achievement can also be expressed by increased interest and engagement. Many primary education practitioners have suggested that early intervention and introduction to science may be one factor that increases student interest (Gokhale et al., 2015).

Tai and colleagues conducted a longitudinal study that began in 1988 with eighth grade students being asked about their future career plans when they were 30 years old. The study concluded in the year 2000 with the participants that obtained a baccalaureate degree. Their results showed that when the students in middle school indicated that they were planning to pursue a career in science, they were almost twice as likely as their peers to have graduated with a four-year degree from a college science program. The researchers suggest that exposing students to science – based careers in eighth grade or earlier, may have a causal effect on their choice of college major (Tai et al., 2006). Tai and colleagues concluded that the students who

showed an early interest in a science career were more likely to graduate from college with a STEM degree, showing a possible link between early encouragement and exposure to science and a career in science.

Bystydzienski and colleagues (2015) conducted a study over a three-year period with high-achieving, female sophomore students in high school. They found that when these students were provided with a deliberate introduction to engineering curriculum and engineering careers, it resulted in an increase in student interest in the field of engineering when they were considering college majors and future careers. This study reinforces the advice of experts in education that STEM education needs to start in middle or even better in elementary school (Bystydzienski et al., 2015). The limitations of a study of this kind is who participants that did not choose to pursue engineering indicated that their reasons were more financially based than a lack of preparation from their high school science classes (Bystydzienski et al., 2015).

In contrast, Kuykendall (2022) reported that female-identified students in high school have more aptitude than interest in STEM careers. This study used aptitude assessments from over 116,000 female junior and senior high school students. Data from these assessments showed that the aptitude scores from the female students for STEM careers "far outweighed their self-defined interest in them" (Kuykendall, 2022). With the projected need for STEM trained workers expected to continually rise, female-identified and BIPOC students will be one of several groups tasked to fill the job openings in these fields. The data suggest that the current trends in both college STEM programs, and STEM degree graduation rates currently will not narrow these identified gaps (Kuykendall, 2022). This study offers one possible explanation for the discrepancy between aptitude and interest by proposing that students are not being guided to

these careers and that early exposure may be a way to remedy the lack of female representation in these fields.

The exorbitant cost of a college education is a roadblock to many women and BIPOC students' college plans. When the cost is prohibitive, this affects underrepresented populations more than their White male counterparts. Collins and colleagues (2020) proposed that STEM engagement could be supported by offering programs to target these groups of students. STEM fields are underrepresented when it comes to women and BIPOC workers. These researchers conducted a study that showed that students that were underrepresented in STEM majors and careers, when able to participate in a science-based, service-learning project, had an increase in engagement and an increase in interest in science both inside the classroom and as a potential future career (Collins et al., 2020). The program was able to show that students who participated in a service-learning project had an improved affinity for STEM careers and supported the idea that culturally relevant learning experiences are important to engage traditionally underrepresented student populations (Collins et al., 2020). This is also supported by the work of Geneva Gay (2002a) and her culturally responsive teaching practices and well as Dewey's (1998) progressive movement theories around hands-on, project-based learning and the experiential learning theory.

It is possible that students that are planning on enrolling in a four-year college with a STEM major may benefit from any opportunity to interact with the content being presented in the classroom. Students who are in their junior and senior year of high school often select science electives that provide them with these types of learning experiences. Colleges and universities offer summer enrichment programs that also serve this purpose. Researcher Diane Markowitz (2004) looked at how a student's opinion on their own ability may have changed after

attending one of these summer programs found at many colleges and universities. This researcher conducted a study to follow-up with participants who, while in high school, attended a summer science program at a university. Markowitz used a survey that focused on how the summer program impacted "students' perceived abilities in higher level science courses, on participation in extracurricular science programs, as well as student interest in pursuing a career in science" (Markowitz, 2004). Students that participated in the program and then the study reported that their participation had a positive influence on their advanced science classes in high school as well as their decision to pursue science as a career. This is another example of how student interest can impact both engagement and achievement in high school and as they move on to a post-secondary STEM program.

Curriculum Bias in Science

Throughout a student's academic career, they are exposed to a variety of different science classes, disciplines, teaching strategies, and pedagogies. California is one of the states that have implemented the Next Generation Science Standards (NGSS) for K-12 science education. These standards were developed and implemented with the goal of improving science education for all California students. "A goal for NGSS was to create a set of research-based, up-to-date K–12 science standards. These standards give local educators the flexibility to design classroom learning experiences that stimulate students' interests in science and prepares them for college, careers, and citizenship" (NGSS, 2021). This is a step in the right direction, but not all classrooms are the same and not all educators have the resources available to offer their students these types of lessons and experiences.

Urban public high schools in large California cities like Los Angeles, San Francisco and Oakland frequently have understaffed schools, large class sizes and students that enter from

underperforming feeder schools (Jepsen & Rivkin, 2009). These students cannot compete with private school students from affluent suburbs that have a distinct advantage over them because they are more likely to have had multiple classes that offered project-based learning opportunities. This may be one of the reasons why female-identified and BIPOC students are not enrolling in STEM majors at the same rate as their White, male peers. Statistical data shows that women are attending college at an increasing rate and currently represent more than 50% of college students, yet they are still underrepresented in STEM majors and fields (Morganson et al., 2010). Morganson and her colleagues at Old Dominion University conducted a study that showed the lack of representation of women in STEM majors and careers and how the numbers of women enrolled in these majors and present in the work force is continuing to decline. The authors investigated the role of social coping as a possible explanation of the gender gap that is present in the STEM field. One of the important conclusions from this research is the importance of peer support for underrepresented populations and the use of mentors to support these students (Morganson et al., 2010). The mentor is often the same race, gender, or ethnicity so that students can see a role model that is similar to themselves. Female-identified and BIPOC students need to see themselves represented as scientists, mathematicians, and researchers when they begin their education, just like their White, male counterparts do when they open textbooks.

By the time most students reach high school, they have often developed a sense of their strengths and weaknesses as a student. This is often reflected in the elective classes that they choose when they are given the opportunity to self-select classes. Traditionally, more young men are found in math and science electives and young women in language arts, performing arts and foreign language classes (Gokhale et al., 2015). This needs to change by providing equitable access to all students before they reach high school. Researchers have used these gendered

beliefs around math ability in high school and how it has potential implications on a student's college major. The authors of this particular research study used the High School Longitudinal Study (a nationally representative sample of U.S. high school students) to investigate how engendered beliefs about ability in STEM classes and careers affected student choice of major as they entered college (Riegle-Crumb & Peng, 2021). The study was able to show that the idea of male superiority in math and science classes is still present. It also was able to demonstrate that women that do choose to pursue STEM majors, are most likely to focus on the biological sciences like nursing, as compared to Physical Sciences like physics or chemistry. The researchers reinforced other studies that have also found that these engendered ideas continue to proliferate and contribute to the gender gap and the leaky pipeline that exists and contributes to the lack of equality in both STEM majors and the STEM fields in the work force (Riegle-Crumb & Peng, 2021).

The attitudes of students when they are enrolled in elective math and science classes in high school is also a factor when they explore possible STEM majors or careers. Gokhale and colleagues (2015) conducted a study that explored the differences in attitudes between male and female students that were considering science and technology majors. One conclusion from this study was that there was a correlation between the amount of experience students had in school with opportunities to engage in science and technology practices and the level of interest and how much they liked these content areas (Gokhale, et al., 2015). This reinforces the idea that early exposure to science labs that involve hands-on learning may result in higher levels of student interest in the field of science. However, it was also shown that "males are often much better prepared for what lies ahead than females, well before they even start at preschool" (Gokhale et al., 2015, p. 513). The research highlights the issue that women and BIPOC students

continue to be underrepresented in STEM majors in college and in these careers as they join the workforce. The researchers stated that women drop out of these courses, even when they are highly-qualified students, at a higher rate than their male cohorts (Gokhale et al., 2015). They continued by explaining that the educational research community has evidence of a continued decline of interest in these fields by young women, resulting in a shortage of qualified scientists, technology workers, and engineers (Gokhale et al., 2015). Gokhale's team of researchers (1996) references Whitehead's 1996 study that provided evidence that "social and environmental factors contribute to the underrepresentation of women in science, including the perception that there may not be equal opportunities" and this is a reason that women may not pursue a science career (Whitehead, 1996). Gokhale and colleagues (2015) introduced ideas for future researchers around retention of female students, attitudes of those students and how to improve enrollment and retention of women once they enter college STEM majors. The authors were attempting to provide strategies to recruit and retain more women into STEM majors and careers by investigating and analyzing the attitudes of the students around female participation in these disciplines.

Gokhale and colleagues (2015) suggest that their research is another example of how it is important to begin these interventions and support of female-identified and BIPOC students before they reach high school. When female-identified and BIPOC students are introduced to role models early on in their education and could work on project-based laboratory investigations in elementary and middle-school, they may be more likely to imagine themselves as scientists when they graduate from high school. This would potentially shift the focus from retainment to recruitment of qualified and interested students that were more representative of the demographics in this country.

Researchers that have explored inclusion and exclusion in schools have important data and conclusions related to STEM focused career pathways for students. There are several studies using elementary school students and their parents who were from various social, financial, and racial backgrounds. Lareau and colleagues (2016) conducted a study focused on third graders and their parents. The researchers used both classroom observations of students and the interviews with their parents. There was a difference between classes (middle-class vs. lower class) as it was applied to how Black families interacted with school staff; and they were able to show that there was still institutional privilege present for the White families (Lareau et al., 2016). There was also an explanation of what defines social and cultural capital and how it was related to school compliance issues throughout the study (Lareau et al., 2016). The surveys and responses that were collected suggested an idea for future researchers to examine how these types of capital are used by different classes of parents in "processes whereby parents gain advantages for their children" (Lareau & Horvat, 1999, p. 295). These authors used the case studies presented in this research to highlight the importance of inclusion of all stakeholders in educating children and the differences in social class, race, and cultures as it applies to social and cultural capital (Lareau & Horvat, 1999). When teachers use culturally responsive teaching inside their classrooms and incorporate the practices outlined by Geneva Gay (2002b) related to inclusiveness, they can begin to see how important accurate representation is to students.

Curriculum Change using Culturally Responsive Teaching

Geneva Gay (2002b) has proposed how the importance of students seeing themselves reflected in the curriculum is to both student interest and engagement inside of the classroom. There are two ideas presented in this study. The second one is the most applicable to this research study. It states that students of color (BIPOC) benefit in any educational setting when

the content that is being delivered to them includes “their cultural heritages, experiences, and perspectives or is culturally responsive teaching (CRT)" (Gay, 2002b, pg. 613). Gay also connects the idea that student achievement and engagement is improved when the curriculum is culturally relevant and reflects the diverse learners and their cultures that are present in the classroom. This is relevant for science teachers because the field of science is always changing, growing, and learning. Geneva Gay concludes much of her writing and research with the idea that education is always evolving and that is never perfect because the classroom needs to employ CRT strategies to make the curriculum more inclusive and in doing so, increasing the engagement of every student.

When student interest is piqued, they are engaged in learning, and they see themselves represented in the curriculum, then the resulting data may show that there is an increased enrollment in STEM majors and fields by women and BIPOC students. Much research presented previously has demonstrated that both women and BIPOC students benefit from targeted support from mentors and peers alike. The previously mentioned teams of researchers led by Bystydzienski, (2015), Collins, (2020) and Gokhale, (1996) have proposed many different strategies to encourage and support the pursuit of STEM careers at the elementary and secondary level. In addition, Russell (2017) conducted research at the Massachusetts Institute of Technology (MIT), focused on supporting first-year female college students by using learning communities. The author is also involved with the National Academies, whose focus is increasing the participation of both women and BIPOC students in STEM-related fields and on how to improve their retention in the field (Russell, 2017). The research resulted in two clear conclusions. The first was that participation in the learning communities resulted in higher completion rates and GPAs of the participants (Russell, 2017). The second was that the minority

(BIPOC) students who were involved with this research were more likely to pursue a STEM major (Russell, 2017). The author suggests that there is evidence to support that the students that participated in the learning communities were more successful than their cohorts that did not and that there is a benefit to both women and BIPOC students to participate in learning communities at MIT (Russell, 2017).

Ong and colleagues (2019) conducted a research study that both discusses and investigates factors (other than interest and being academically prepared) that affect whether women, BIPOC women, and BIPOC students' decision to stay in a STEM major or field. It focuses on students in these underrepresented groups that have experienced either isolation or microaggressions or both. The authors talk about counterspaces, which are defined as "academic and social safe spaces that allow underrepresented students to: promote their own learning wherein their experiences are validated and viewed as critical knowledge; vent frustrations by sharing stories of isolation, microaggression and/or overt discrimination; and challenge deficit notions of people of color (and other marginalized groups) and establish and maintain a positive collegiate racial climate for themselves" (Ong et al., 2018, p. 209). They conclude by explaining the importance of counterspaces for women and BIPOC STEM students and expand upon previous research that focused on only one minority group. The researchers offer up many suggestions for future research and propose multiple levels of support for underrepresented groups in STEM majors and careers to both recruit and retain these workers.

This is another research study that highlights the importance of women and BIPOC students having both a safe space and a community of support. It also reinforces the fact that women and BIPOC students continue to leave STEM majors and STEM careers at a higher rate than White male counterparts, and it will lead to a critical shortage of qualified technology

workers in the future for the United States. This is where teachers, school counselors and advisors play an important role because students who are members of these underrepresented groups need targeted support and a safe space for these students to explore these classes.

Summary

The importance of student interest, engagement, and representation inside of the classroom is the basis on which this research study is supported. The goal of a teacher should be inclusivity, equity, and increasing academic achievement of every student. Using culturally responsive teaching practices is one way to accomplish these goals. Teachers who are able to implement the five essential elements of CRT: "developing a knowledge base about cultural diversity, including ethnic and cultural diversity content in the curriculum, demonstrating caring and building learning communities, communicating with ethnically diverse students, and responding to ethnic diversity in the delivery of instruction (Gay, 2002a). It stresses the importance of students being able to see themselves reflected in the curriculum as a pathway to increase both engagement and student achievement.

This action research project attempted to demonstrate, that when CRT is used to identify weaknesses and gaps in the traditional curriculum being presented to all students, changes can be made to increase student interest and engagement. This element presents the idea of symbolic curriculum (images, symbols, icons, mottoes, awards, and other artifacts) that are used to convey the importance of the information students see and to devalue the information that is not there (Gay, 2002a). These practices can assist teachers with creating a classroom environment and relevant curriculum to students that are not reflected in the traditional, mainstream demographics in the United States.

Research on increasing student interest in STEM majors are careers has focused on extracurricular opportunities, targeted student groups that have demonstrated interest, and on supports to keep women and BIPOC students that have already enrolled in these majors, in these programs. There have been outreach programs and research designed around a specific course of study, for example engineering careers. However, there are few studies using the field of forensic science and the introduction of intentional examples of scientists that reflect the demographics of the classroom, to encourage interest from female-identified and BIPOC students. My action research project was conducted to add to this research and collect data to provide a way for other disciplines to increase interest in STEM careers in their content areas. This action research was conducted with 120 junior and senior high school students enrolled in four different sections of forensic science.

Conclusion

This research study examined how the explicit teaching and learning about women and BIPOC scientists was introduced into the forensic science curriculum affected junior and senior students' interest in a STEM major or career. The previous research supported the idea that student interest can be increased through various targeted strategies and that these strategies can be crafted for a select group of students. The theoretical framework used to support this research was based on both experiential learning theory and culturally relevant teaching theory. Student interest, curriculum bias in science and CRT were examined through several different research studies, using elementary, middle, high school, and college students. Examples of successful practices that increased student interest in a potential STEM major and supportive strategies that helped to retain women and BIPOC students already enrolled in these programs were explored. By attempting to understand how CRT practices in a classroom could increase student interest in

a STEM major or career and collecting data to support this hypothesis I was attempting to support the curriculum changes made during this action research project. This research has the potential to assist in curriculum planning throughout a diverse cross-section of science disciplines and potentially attempt to fill the void of qualified STEM workers that will be needed in the United States for decades to come.

Chapter III

Methods

The purpose of this study was to investigate what factors influence female-identified students and BIPOC students' interests in science or STEM majors in college, with a particular focus on the forensic science disciplines. I hypothesized that part of the low enrollment in my forensic science classes stemmed from these students not seeing themselves reflected in the STEM workforce or not having role models that have the same ethnic, racial and/or gender backgrounds as the students enrolled in the classes. The number of female-identified and BIPOC students have increased in my elective science classes over the past several years. Although I continue to see more students choose to take these *classes*, the number of female-identified and BIPOC students from our school who choose STEM or other science *majors,* particularly in the forensic science field, as they move onto college has not increased. When I compare these students and their post-secondary plans with the other class I teach, AP Biology, where close to 70% of those students have plans to major in a science discipline, approximately 5% of students enrolled in forensic science indicate that this will be their college major. The demographics of the students in both subjects are almost identical with regard to race and gender identity. The primary goal of this study was to increase the number of female-identified and BIPOC students that may consider the field of forensics as a potential career.

Research on experiential learning theory (Kolb, 2015) has shown that information is retained better when students are engaged in a learning process that allows them to have hands-on opportunities to interact with the content of the course. The goals of experience-based learning is more meaningful when students have a personal connection to the content (Andresen

et al., 2000). This pedagogical practice, when partnered with a hands-on learning, would allow both female-identified and BIPOC students to bridge these two ideas.

Culturally responsive teaching is a theory put forth by Geneva Gay that has shown that when what is being taught is connected with the experiences of the students, they then become more meaningful and can result in both higher academic achievement and engagement (Gay, 2002b).The examples of working professionals in the STEM field that accurately reflects the growing number of racially, ethnically, and culturally diverse students helps a new group of previously overlooked students to make connections to the curriculum. This study examined how the intentional exploration of women and BIPOC scientists in the forensic curriculum impacted students' interest in pursuing a career in science, with an emphasis on the field of forensics. The research question posed in this thesis explored how intentional exposure to scientists that accurately reflected the demographics of the classroom, influenced how students potentially saw themselves pursuing a STEM major or career. I asked: *How will the addition of explicit teaching and learning about women and BIPOC STEM professionals in the forensic science curriculum increase junior and senior student's interest in a STEM career or major?* Specifically, I hoped to increase students' interest in the forensic field and see more female-identified and BIPOC students consider a STEM career.

Setting

The setting in which this action research project was conducted was in a suburban comprehensive high school in Northern California, identified as a targeted Title 1 school. Title 1 schools receive federal funding to support struggling students and schools to close the achievement gap and meet the state's academic standards (California Department of Education, 2022.). The area was originally a rural farming community but has experienced a large influx of

new residents over the past two decades resulting in a more suburban community at the time of the inquiry. During the time that this action research project took place, there were approximately 2,500 students enrolled during the 2021-22 school year. This school is one of three comprehensive high schools in the district that opened in the mid-1990s. At the beginning of the 2000-2001 school year, approximately 1,700 students were enrolled. The original structure of the school had four communities or buildings, each with a designated school counselor, assistant principal, and secretary, and students were placed into one of these buildings upon enrollment and stayed with the same support staff until they graduated. This was a way to ease the transition from middle to high school and to allow students to develop relationships among themselves and the building staff. Although the original structure remains, the influx of students has seen the addition of a dozen portable classrooms and four new wings added, resulting in a significant increase in students in all four buildings, without an increase in support staff.

One issue that had an impact on this action research project was the COVID-19 pandemic. This school site is in a district that transitioned to full distance learning in March of 2020 and stayed that way for an entire year. Parents were given the option of allowing students to return to the classroom in March 2021, with a reduced day schedule, fully masked, and following the California Department of Education's guidelines that were set by the Center for Disease Control (CDC). Less than half of the students elected to return at that time, and as the fourth quarter of the 2020-2021 school year progressed, more students made the decision to go back to distance learning, rather than stay in the classroom. During the school year, 2021-2022, the school site where this action research took place had all students return to the classroom for in-person learning. This was a difficult transition for students, families, teachers, and the community. Anecdotal data from the staff suggested that more students were depressed,

disengaged, failing, and many of the seniors have had to either transfer to one of the districts' two alternative high schools or elect to complete a fifth year of high school to graduate. Much of the instructional time during the first weeks of the school year were spent easing students back into a full day of classes and focusing on student's emotional well-being, rather than on content and teaching standards. The administration and staff have been working towards a gradual reintroduction to a traditional school schedule and norms, but the students have not embraced this and continue to struggle academically and emotionally. This has affected student engagement in class and post-secondary plans of a large group of students who are choosing community or junior colleges rather than enrolling in a four-year college or university after graduation. The most current data, as reported by the students from the graduating class of 2021, show that 62% planned to enroll in community college, 21% in a 4-year college, 8% were joining the workforce, 7% chose to enter the military, and 2% went into a vocational program.

There were approximately 125 staff members at the site during the 2021-2022 academic year. The self-reported gender breakdown was 62% female-identified and 38% male-identified. The overall demographics of the student population at the school site has become more diverse since the school opened in the mid-1990s, but the staff still largely identified as White (70%). The remaining staff members identified as: 13% Latinx, 10% Asian (this included Asian Indian, Alaskan/Native American, Chinese, Filipino and Korean), 6% African American and 1% that declined to answer. These data clearly indicate the differences between the racial/ethnic demographics of the staff and the students who are in their classrooms. During the 2021-2022 school year, all the teachers were credentialed, except for the two intern teachers on staff. At the time the study was conducted, the average number of years teaching in general, as reported, was less than 10, indicating that there was a high degree of turnover at this school site.

The demographics of the student population for the 2021-2022 school year were: 46.7%, Latinx, 27.5%, White, 9.8%, African American, 5.5%, Filipino, 5.2%, students who identified as two or more races, 3.6%, Asian, 0.4%, American Indian/Alaska Native and 0.35%, Pacific Islander. This demographic breakdown is reflective of the increase that is being seen throughout California, as a more racially diverse student population is replaces what was once a White majority in the classroom and at this school site. Using the information from the California Department of Education School Accountability Report Card (SARC) for the year 2020, approximately 44% of students were socioeconomically disadvantaged, 39% qualified for free or reduced lunch, 14% were identified as students with learning disabilities, 7.4% were English Language Learners (ELL), 2% were homeless (defined as lacking a permanent address), and 0.4% were foster youth (School Accountability Report Card, 2020.).

It is important to note that the most recent data from the California Assessment of Student Performance and Progress (CAASPP) is from the 2018-2019 school year. Approximately 63% of students either met or exceeded the English Language Arts (ELA) standard, while only 24% met or exceeded the standard for Mathematics. When focused on the Latinx population, which makes up the highest percentage of the student demographic, the ELA drops to 59% and math to 18% proficiency. When the scores are compared by gender, the results show that female-identified students demonstrated 70% proficiency in ELA and 23% math versus the male-identified students' scores of 56% in ELA and 25% in math for the 2018-2019 school year (CAASPP, 2019.).

One of the three long-term, school-wide goals that were identified by the staff and administration at this school site was to increase the number of students who were college and career prepared. The data from the 2018-2019 SARC profile show that the graduating classes of

2017 and 2018 were identified as having approximately 47% of the total graduates being college and/or career prepared. The numbers drop for the class of 2019 to only 41% identified as prepared, a decrease of 6%. Over those three years, the percentage of graduates identified as *not prepared* remained between 28% and 29%. The overall district data for 2020 shows that there were approximately 8,300 students enrolled at the end of the 2019-2020 school year and that over 2,000 students graduated in 2020, with an overall 49% being college and/or career prepared. The report also states that approximately 270 students were able to meet the UC/CSU A-G course requirements, which is 49% of the graduating seniors that qualified for admission to one of the UCs or CSUs by earning a grade of "C" or better in all the required courses.

Demographics of the Classroom

The research was conducted in four forensic science classes with a total of 120 junior and senior students, all between the ages of 16 and 18. Juniors comprised 58% of the students and seniors made up the remaining 42%. Of the 120 students, 62% identified as girls and 38% identified as boys. The demographic breakdown of the four sections of Forensic Science was: 41% Latinx, 31%, White, 8%, Filipino, 8%, Asian, 7%, African American, 5%, identified as 2 or more races, and ≤ 1%, American Indian or Alaskan Native. My standard practice has always been to have every student entering both AP Biology and Forensics complete ratings on exit tickets to express their interest in the units covered in both year-long courses. These are Likert-type scales with scores of 1 to 10, and students answer based on their interest level in the unit and the activities that were completed during the unit. At the semester break in December, a total of 10 students left the forensic science classes for a myriad of reasons, including transferring to another school, moving out of the district, and failing to meet graduation requirements.

Research presented previously has demonstrated that all students benefit from targeted support from mentors and peers alike (Russell, 2017). The forensic science class is structured with a large percentage of class time spent exploring project-based, hands-on activities in small groups. Researchers have proposed many different strategies at each level of a students' education to encourage and support the pursuit of STEM majors (e.g., introduction in pre-school, targeted female-identified and BIPOC student mentors in middle and high school, and free extra-curricular and summer STEM programs). By allowing students to experience how actual forensic scientists work collaboratively in real-world situations, students can begin to imagine themselves as working scientists. Including all the students enrolled in the classes, the focus groups of BIPOC students and female-identified students were compared to their White male peers and using quantitative data to analyze the results of the targeted interventions aimed at increasing enrollment in post-secondary STEM programs.

Data Collection Strategies

Over the course of the 10-week period when the action research was conducted, three data collection strategies were used. To gauge shifts in students' interest in STEM careers, I collected data via exit tickets, observation protocols, and a college major essay. Since exit tickets are embedded into the curriculum and used regularly to gauge interest and used to plan future units, quantitative data from the beginning of the school year were used as a baseline for student interest. Qualitative and quantitative data were both collected and analyzed. The exit tickets that were used for pre and post unit ratings, based on the Likert Rating Scale, was the primary source of the quantitative data. Student answers from the open-ended questions on the exit tickets were used as both quantitative and qualitative data sources, where students could explain their answers to the Likert-type statements and a tally of responses could be counted and expressed in a graph

to represent the breakdown of answers by demographic group. Qualitative data were also collected from my observation protocol, and the college essay completed at the end of the study. Only the students that indicated that they were going to pursue a forensic science major or minor had the information from this essay included in the analysis of qualitative results; however, the percentage of the whole group was reported quantitatively.

Exit Ticket Ratings

At the beginning of the school year, as is my standard practice in all my classes, students are required to return a syllabus, signed by a parent or guardian, indicating that they have read and understood the outline of the course and the expectations in the classroom. Part of the syllabus includes an interest rating, using a scale from 1 – 10 asking students to rate their interest in the course content before any material is presented. This score was used as a baseline to see what, if any, increases and/or decreases in student interest throughout the entire year-long course. All the data were collected from exit tickets and recorded in an Excel spreadsheet and the data was organized into tables, charts, and graphs to be analyzed. The same interest rating scale was used at the beginning and end of every unit covered over the time the survey was conducted and at the end of the study.

All 120 students in the four sections completed the exit ticket for the first time when they returned a signed copy of their syllabus. At the end of the year, students are given one final chance to rate units and activities over the course of the year. I have used this information in the past to eliminate low-scoring units and increase the time spent on higher-scoring units or time to introduce new topics in forensics. This has allowed me to base my course content on student interest and feedback. For the purposes of this action research study, students were assigned into one of four demographic groups: BIPOC female-identified students, White female-identified

students, BIPOC male students, and White male students. Using these data groupings, the demographics of the study participants were as follows: 43% BIPOC/female-identified, 25% BIPOC/male-identified, 19% White/female-identified, and 13% White/male-identified.

Data were collected from all 120 students enrolled in the forensic science classes. The rationale for this was to obtain a complete overview of student interest, to have a large data set, and to include every point of view enrolled in the classes. By soliciting the input from a sample size of 120, that data set increases, the estimates were more accurate, and the conclusions drawn were more reliable than using one class section of 30 students to represent the whole forensic science cohort. Students were informed of the action research and the rationale behind how their opinions would be used in the study with the intention of observing when student interest was piqued, with the assumption that if they were engaged in learning, and they saw themselves represented in the curriculum they would reply with accurate interest ratings.

Exit Ticket Opinion Questions. The opinion questions from the exit tickets were used as both qualitative and quantitative data for analysis. The exit tickets were distributed at the beginning and end of every unit of study. It should be noted that the exit ticket that is distributed at these times is the same and students were able to see their initial interest rating of the unit before any material was presented. As this is part of my teaching practice, the quantitative data collected and analyzed was from the beginning of the school year until the end of the research study. However, the qualitative data *reported* began at the start of the 10-week inquiry period, after Institutional Review Board approval was obtained, and was completed at the end of the study. The student responses were separated by demographic group or by race or gender. Responses were coded by assignment type or name and presented as quantitative data from answers to open-ended questions included in the exit tickets. Based on exploratory questions

such as “What lab or activity did you enjoy the most during this unit?” and “What changed your initial rating in this unit (either an increase or decrease) and why?” Individual student responses, with all identifying information removed, were used as qualitative data to support analysis throughout the action research project.

Observation Protocol

I collected observation protocol notes during every laboratory investigation, mock crime scene, and table group activity throughout the 10-week period. The observation protocol notes focused on students’ roles during group work in the classroom. I wanted to see which students chose to lead their group, how the roles were assigned, and to collect quantitative and qualitative data as the students worked. Once the students began work on their laboratory investigation or crime scene scenario, I circulated around to each group of three to four students and took notes on the group leaders. I made tally marks during each class period to indicate if a female-identified or BIPOC student was the group leader. At the end of each period, I tallied this number out of the total number of groups in the class period. At the end of the days where the students worked in groups for the entire class period, I totaled all the groups in all four sections and then the percentage of those groups with the leader in one of the targeted demographic groups. My research question was focused on interest levels, and I collected these data in part, for that purpose.

During this time spent observing and circulating around the classroom, I took notes on any issues, statements, or feedback I received around the roles in the tasks. At the beginning of each unit, I encouraged all students to take a leadership role in one of the group tasks during the unit. By using this informal questioning during class time, I was able to collect information and student statements to provide context to be used later for data analysis.

College Plan Essay

This was assigned to the remaining 110 forensic science students who were still enrolled in the course at the end of the 10-week research study. This assignment was completed during class time and students who were absent were provided with an on-line option to complete this writing task. The college plan essay contained multiple levels of analysis. Students were asked to compose one paragraph, at a minimum, about their college major, career plan, or field of study. The essay had a short information section at the beginning so I could identify each student's intended major, and whether it was in the STEM field or a forensic science discipline. Next, students indicated whether they were in their junior or senior year. They were then asked to indicate what their plan was after graduation.

Students who responded that they were not going to attend college and either enter the workforce or join the military were counted then excluded from the next step in the data analysis. Students who were planning to attend a four-year college or university or a junior college were asked about their intended major upon enrolling. Students who indicated that they were intending to pursue a STEM field were separated from the other responses that indicated a different post-secondary plan, and those essays were counted but not part of the final data analysis. Of the remaining responses in the STEM field, the seniors who had accepted or were planning to accept a spot with a forensic science major or minor and the juniors who planned to apply and accept an offer to attend a forensic science program were collected for the final data analysis. Those essays were included in both the quantitative and qualitative data analysis. The quantitative data was used to gauge interest in a post-secondary major or career in both the STEM field, and specifically forensic science. I was particularly interested in how many female-identified and BIPOC students had indicated an interest in these potential majors and careers.

Procedures

One of the continuing issues that I believe is preventing more students from pursuing STEM majors is that female-identified students and BIPOC students do not see themselves reflected in the curriculum or in the job field. By deliberately bringing in specific examples of professionals in the field that accurately reflect the demographics of the incoming freshman student population, perhaps more of these students and possibly more students in general will consider science as their future career. I began the year by reviewing the syllabus and introducing the Likert-type rating scale that I use consistently throughout the year on the exit tickets that were distributed to all students. I informed the students about the action research and my interest in equity and access for every student enrolled in my classes. Students were given a visual tour of the classroom where I had pictures of women and BIPOC scientists posted around the room. I decorated the doors in my classroom with inspirational quotes by women and BIPOC innovators in multiple disciplines related to Forensics. The first activity of every unit was the exit ticket ratings based on student interest. Next, I used short biographies of both women and BIPOC scientists when new units were introduced. These were embedded into the PowerPoint slides that were shown to students as they took guided notes at the beginning of any new unit. Additionally, African American women scientists, inventors, and mathematicians were highlighted during Black History Month, and when our school held its annual Pride Conference in February 2022.

Students were encouraged to find other examples of scientists or other STEM professionals that inspired them or represented their race, gender, or cultural backgrounds. This was a required component of the Quarter 1 research assignment where students created a poster of a forensic discipline to present to their class. Student input was solicited at the beginning and

end of every unit taught in forensic science. I collected both quantitative and qualitative data from exit tickets, and ratings based on changes in interest pre and post unit and as the course progressed. Students were able to identify activities, labs, or any information that was introduced in the unit that inspired an interest in that field or topic, as well as anything that may have been presented that did not interest them or negatively impacted their view of that career or potential college major.

Table 1 contains information about how the forensic science class was structured during the 2021-22 school year, during the period when the action research took place, and outlines the scope and sequence of the curriculum. One of the targeted interventions that was added to the lessons was the addition of a woman or women working in the field of forensics, specifically in the unit that was being covered, or a BIPOC scientist or professional that was in the news at the time and had a STEM career. During Unit 8, the school site celebrated Black History Month and the scientist during that time was also featured on my classroom door. Each unit was started with an overview of the discipline, presented by PowerPoint slides and this was the most common place where the forensic scientists and professionals were introduced to the students. Then each unit had a series of activities, most were completed in student groups of three to four and involved hands-on opportunities for students to interact with the materials and experience the way a forensic scientist might act while investigating a crime. Students were given additional activities to practice techniques or to review for unit exams during the units and each unit usually concluded with a short video featuring the main ideas from the unit or a famous case featuring the unit of study. Within these videos, featured professionals that were female-identified or BIPOC scientists were used as well.

Table 1.

Scope and Sequence of Units.

#	Unit Title	Featured Professional(s)	Hands-on Labs and Activities or Investigations
1	Introduction to Forensics	Female department heads in the FBI and CIA	a. Crime Scene Sketch – Using math to determine area and perimeter. b. Quarter 1 Forensic Discipline Project
2	Evidence	Baltimore Maryland's Forensic Department and Laura Pettler	a. Web quest: Featured Professionals https://foxbaltimore.com/news/local/female-forensic-scientists-lead-the-way-at-the-baltimore-police-department b. Campus wide evidence search c. Blood Map – Jeffrey MacDonald Case
3	Anthropology	Dr. Kathy Reichs and Clea Koff	a. Skeleton Reassembly b. ID Skeletal Remains c. Using bones to determine gender, race, and age of a victim (3-D Examination)
4	Blood Spatter	Dr. Kizzmekia Corbett – CDC, Dr. Bennet Omalu	a. Gabby Petito Case b. Walking/running drip patterns c. Blood drop diameters from different heights d. Cast-off patterns using different weapons e. Area of Convergence f. Angle of Impact
5	Fingerprints	Frances Glessner Lee	a. Individual Student Prints – 10-card of prints b. Analyze Fingerprint patterns c. Lifting fingerprints from surfaces d. Matching lifted prints to suspect prints
6	Arson	Kathy A. Notarianni and Steven Bardwell	a. Q2 Project – Urban Myths and Legends b. Arson Podcast Case c. Willingham Case review, using arson evidence to solve a crime
7	Psychology and Behavior	Professor Angela Gallop and Michelle McNamara	a. Depravity Scale Ratings Visual b. Psychological profiles of famous serial killers c. Q3 Project – Wanted Poster
8	Handwriting, Forgery and Document Analysis	Dr. Mae Jemison – NASA Astronaut and CeCe Moore	a. Peer Handwriting Sample Analysis b. Forgery Lab c. College Plan Essay
9	Toxicology	Dr. Clare McCarthy and Rachel Carson	a. Teenage Drug Use Data Analysis b. Prussian Blue Case Investigation

I circulated throughout my classroom while students were working in groups and took notes in a field journal to document which student was leading the group discussion, the lab investigations or task assignments. Students were required to assign roles, and keep a record of them, for each summative investigation in every unit and that information was collected to determine how often female-identified and BIPOC students were leading their groups. Data from a college major essay, given in the spring were also used to obtain post-graduation plans for senior students and college major or career plans for the juniors. These data were used to obtain a big-picture view of how the inclusion of both women scientists and BIPOC scientists had an influence on the engagement during any Forensic Science unit and how that interest level changed at the beginning at the end of the units covered by this research study. These data were organized into a table that represented the timeline of the class by week, data collected, and units covered.

Plan for Data Analysis

The purpose of each one of the three data collection tools used in this action research study was to provide qualitative and quantitative data to investigate how, explicit teaching and learning about women and BIPOC scientists into the forensic science curriculum affects junior and senior students' interest in a science career. There were nine total units from the beginning of the year and four completed units throughout the 10-week study. All the participants took pre and post unit surveys that asked them to rate their interest in the unit topic and identify activities presented in the unit that had changed their ratings at the end of the unit. The three individual data sources were used to triangulate the data to provide a more in-depth analysis when the results were interpreted at the end of the action research study.

Exit Tickets

Exit tickets were used throughout the course, at the beginning and end of each unit, to gauge student interest pre and post unit throughout the 10-week study. The baseline data was gathered from the syllabus from the beginning of the year. The quantitative data from the Likert-type scale was used to determine the overall change in interest by each of the four designated demographic groups in each unit. Four demographic groups were created to show the breakdown of each group from the 120 students in the study. Units that received a high or low interest rating from one or more of the targeted groups had qualitative data from the exit tickets analyzed to provide evidence to support the results. The data were analyzed by both racial/gender groups, as well as the whole cohort data. The exit tickets also included open-ended questions and statements that students either agreed or disagreed with. These answers were tallied and used to support conclusions at the end of the study. Specifically, I focused on what activities increased student interest versus those that had possibly decreased student interest or engagement during a specific unit. Over the course of the study, I collected approximately 10 exit tickets per student. At the end of the first semester, the question on the exit ticket asked, "Name any scientist from the semester that made an impact on you." These data were broken down by gender and the results used to see if there was a possible connection between the results and the intervention used in this study. The question was intended to identify how many students, and their demographic group, recalled any of the women introduced during the units covered prior to the semester break.

Observation Protocol

An observation protocol tool was used to quantify the number of BIPOC and female-identified students that took on a leadership role during group work in class and student's

rationales as to why they were in a lead or supporting role. Student comments were collected as direct quotes and recorded in the data collection tool and the number of BIPOC, and female-identified group leaders were counted by tally marks. A total of approximately 100 observations were recorded over the course of the study. These data were collected during every unit laboratory investigation or crime scene activity, when they were working collaboratively in their lab groups of three to four students. The information was recorded and then added to the observation protocol stored on my classroom computer. To analyze these data, I did a summary of the number of activities in each unit, the total number of groups in each class, the total number of groups in the four sections of forensics, and the total number of girl students or BIPOC students that were identified as the leader of that activity. The data were analyzed to see patterns and connections to student interest in a particular unit of study when compared to the quantitative ratings from the exit tickets.

College Plan Essay.

The college plan essay was assigned during the last week of the study. This data source identified the students that were planning on enrolling in a post-secondary forensic science or STEM program and the senior students that had been admitted into one of the programs. Those responses were the only ones included in the results reported. These essays contained both quantitative and qualitative data. All data were counted, tallied, and expressed as a percentage of the whole cohort in the four classes. Data on percent planning on attending college, percentage with a STEM major, percentage pursing a forensic program or degree, and breakdown by gender and race, and grade in school were included in the data analysis.

Summary

The goal of this action research project was to increase the number of female-identified and BIPOC students that may consider the field of forensics as a potential career. This study examined how the intentional exploration of women and BIPOC scientists in the forensic curriculum impacted students' interest in pursuing a career in science, with an emphasis on the field of forensics. Before this study, the enrollment in my forensic science classes had been steadily increasing, and the number of female-identified students eventually outnumbered their male peers. This was not the case when I began teaching this course seven years ago. I questioned, in part, that if female-identified students and BIPOC students in general, were demonstrating a growing interest in enrolling in the class, why were more of them not choosing to pursue this as a major when moving on in their post-secondary educations? The data collected were used to determine if one of the issues preventing students from entering a STEM major was the lack of representation of a diverse group of examples of scientists currently working in the field.

Teacher observation protocol notes, student's answers from open-ended questions on the exit tickets, and an essay at the end of the study were used to measure both increases and decreases in interest levels and engagement throughout the study. Both the quantitative and qualitative data were analyzed. Student ratings on interest in a forensic career or area of focus were tracked throughout the action research project and the students that indicated through their responses on the college essay that they planned to pursue this STEM field had those responses analyzed at the end of the study.

The information in this chapter established the setting where the action research took place, along with the demographic profiles of the participants, the collection strategies and data

sources used, the procedures followed, and an explanation of how the data was triangulated from the individual sources. In the next chapter, a more in-depth analysis of the data is discussed using both the quantitative and qualitative data from the student responses and observation protocol notes.

Chapter IV

Findings

The COVID-19 pandemic has had a long-lasting effect on the education system in the United States. Teachers, students, their families, and districts alike have all had to make major adjustments in how content is delivered to students. Mental health concerns, physical well-being and learning loss mitigation continue to be significant issues that affect all stakeholders. Prior to the pandemic, the need for STEM prepared workers was increasing but the number of students enrolled in these post-secondary programs was decreasing (Griffith, 2010). As a science teacher, I had a particularly tough time adjusting my teaching practices from in-person classes to a distance learning framework because of the challenge of losing the interactive and cooperative laboratory investigations in the curriculum. The benefit of being able to provide students with opportunities to interact with the content by offering hands-on activities drastically decreased during this timeframe. This exacerbated the issue for female-identified and BIPOC students that have not been provided with equitable opportunities to see themselves as successful STEM students (Collins et al., 2020).

Research suggests that students may benefit from experiential learning. Beginning with the work of John Dewey (1986), a pioneer in the progressive education movement, there is strong support for the idea that student interest was critical when presenting material in the classroom. Many researchers were working scientists, teaching simultaneously, who emphasized hands-on learning experiences inside of the classroom to increase engagement with the curriculum (Kolb, 2015). Geneva Gay (2002b) demonstrated the importance of culturally responsive teaching (CRT) and the importance of the teacher's knowledge and recognition of the unique demographic make-up of the students in their classroom that allows students to connect

with the content being presented. When what is being taught is connected with the experiences of the students, the lessons then become more meaningful and can result in higher levels of interest, achievement, and engagement (Gay, 2002b).

The purpose of this study was to explore factors that may influence female-identified students and BIPOC students' interests in science or STEM majors in college, with a particular focus on the forensic science field and its related disciplines. I used a variety of different strategies in the classroom to expose students to a wide range of women and BIPOC scientists and professionals that worked in these fields and represented the demographics present in the classroom when this research was conducted. I asked: *How will the addition of explicit teaching and learning about women and BIPOC scientists in the forensic science curriculum increase junior and senior students' interest in a science career?* Specifically, I hoped to increase students' interest in the forensic field and see more female-identified and BIPOC students consider a STEM career, as well as contributing strategy to increase interest by female-identified and BIPOC students in all science disciplines.

Overview of Methods and Data Collection

Data were collected at the beginning of the 2021-22 school year to be used as a baseline for student interest during the pre-intervention stage of this action research project. All 120 students enrolled in forensics were given a syllabus that contained a Likert rating scale, from 1 to 10, that asked participants to rate their interest level in the class before any material was presented. The syllabus (Appendix A) was the first assignment given which needed to be returned completed, with a parent or guardian signature, a student signature, the interest rating from 1 to 10, and an acknowledgement of all the policies and expectations in the class. This was the only required piece of data collected, the remaining information was requested of the

participants, but all of them had the option to not participate or only provide partial answers during the 10-week period when the research was conducted.

During the 10-week period, three data collection strategies were used to measure participant's interest in the specific forensic units and the subject overall. I collected data via exit tickets, observation protocols, and a college major essay. I explained to the students that exit tickets are embedded into the curriculum and used regularly to gauge interest and used to plan future units and would be distributed throughout the year-long course. Student answers from the exit tickets where open-ended questions were asked, were used as both quantitative and qualitative data sources, where students could explain their answers to the Likert-type statements and a tally of responses could be counted and expressed in a graph to represent the breakdown of answers by demographic group.

Qualitative data were also collected from my observation protocol and the college essay completed at the end of the study. The observation protocol focused on the number of female-identified and/or BIPOC students that were leading the group lab activity or investigation during the class period. I circulated throughout the classroom and used tally marks to count the number of students from the targeted demographic groups that were in a leadership role. Then, the college plan essay was distributed during the last week of the research study period. Only the students who indicated that they were going to pursue a forensic science major or minor had the information from this essay included in the analysis of qualitative results; however, the percentage of the whole group was reported quantitatively. The number of participants that indicated that they planned on a major or career in another STEM field were identified, as well as the remaining students who completed the assignment.

Demographics of the Participants

The participants in this action research project were enrolled in four forensic science classes during the 2021-22 school year. The students met a set of pre-requisites that allowed them to choose the forensic science elective at the end of their sophomore of junior year. A total of 120 junior and senior students participated, all between the ages of 16 and 18. Juniors comprised 58% of the students and seniors made up the remaining 42%. Students were asked a set of demographic questions at the beginning of the school year, included on the course syllabus, and self-selected both their race and gender. Of the 120 students, 62% identified as female and 38% identified as male. The demographic breakdown of the four sections of Forensic Science was: 41% Latinx, 31%, White, 8%, Filipino, 8%, Asian, 7%, African American, 5%, identified as 2 or more races, and ≤ 1%, American Indian or Alaskan Native (Table 2).

Table 2

Frequency and Percentage of Demographic Variables (N=120)

Variable	Frequency	Percent of Total
Ethnicity		
Latinx	49	41%
White	37	31%
Filipino	10	8%
Asian	10	8%
African American	8	7%
Two or more races	5	5%
American Indian or Alaska Native	1	≤ 1%
Gender		
Female-Identified	74	62%
Male-Identified	46	38%

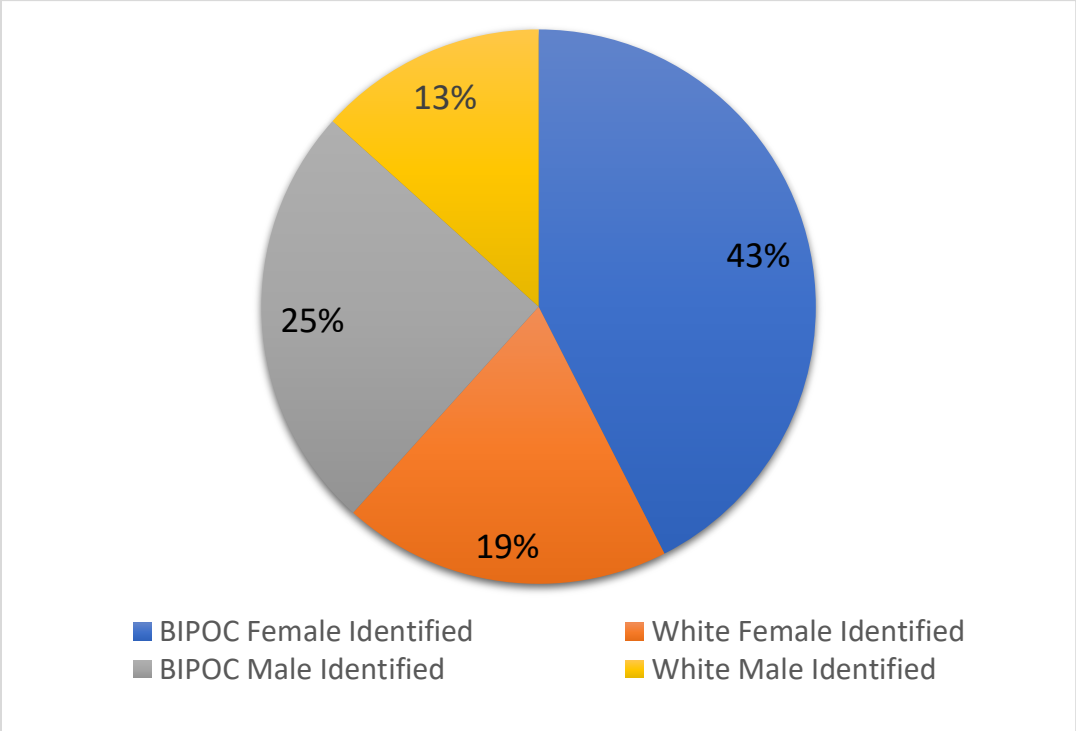
My standard practice has always been to have every student entering both AP Biology and Forensics complete ratings on exit tickets to express their interest in the units covered in both year-long courses. These are Likert-type scales with scores of 1 to 10, with 1 representing the

lowest level of interest and 10 representing the highest. Students were requested to answer based on their interest level in the unit and the activities that were completed during the unit. At the semester break in December, a total of 10 students left the forensic science classes for a myriad of reasons, including transferring to another school, moving out of the district, and needing to drop forensic science to add a class to meet graduation requirements.

Figure 1 demonstrates the responses to the demographic questions that were included on the course syllabus, distributed at the beginning of the school year. Students (N =120) were asked to identify their preferred, self-selected gender and race. As reported in Figure 1, 62% of the students were female-identified and 38% identified as male. BIPOC students comprised 68% of the four classes, while White students made up the remaining 32%.

Figure 1

Student Demographic Subgroups used for Analysis



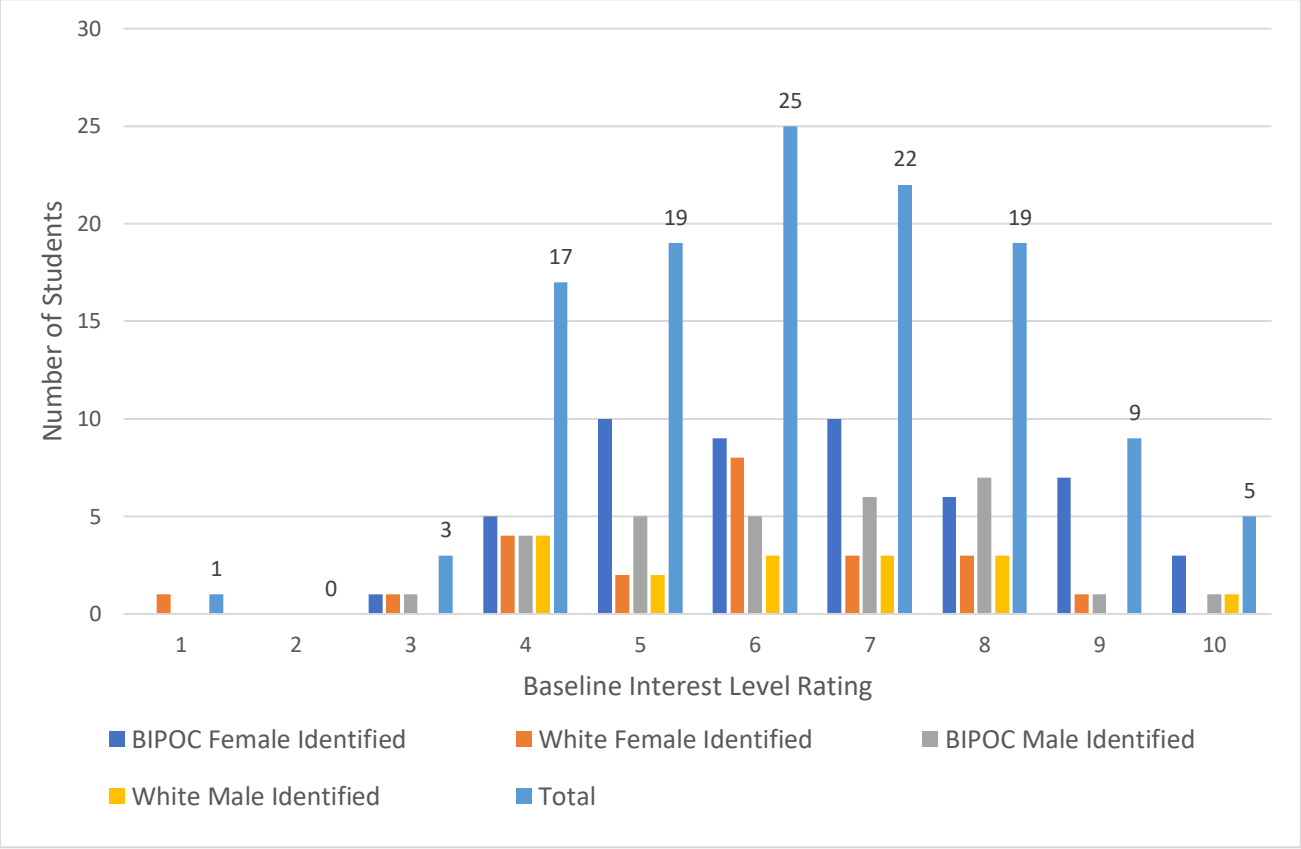
Note. N=120, the total number of students enrolled in Forensic Science at the beginning of the school year.

Analysis of Exit Tickets Ratings

Exit tickets are a customary practice used in all my classes to measure both interest levels and identify activities that increased student engagement in individual units and in the class. Traditionally, the information collected is used at the end of the year to eliminate low-scoring units and activities and increase time spent on other units that students reported high levels of interest and laboratory investigations that enhanced student learning. The mean value for student level of interest in forensic science at the beginning of the course was 6.33 (Figure 2).

Figure 2

Baseline Level of Interest in Forensic Science class from Syllabus by Demographic Subgroup

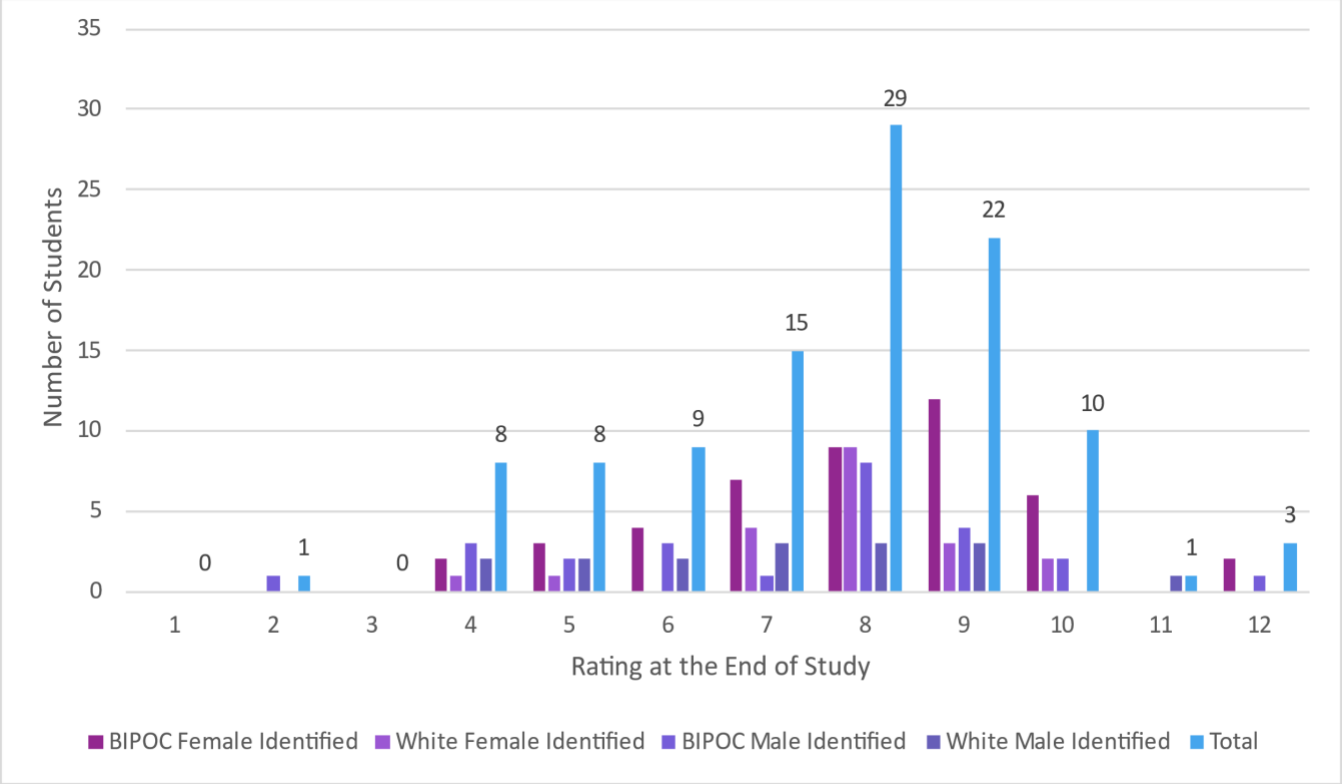


Note: N=120, all enrolled students were required to return a syllabus with a rating.
The Interest scale used was from 1-10, where 1 is the lowest and 10 is the highest.

The final interest rating was embedded in the college plan essay, distributed to the students during the final week of the action research project. At this time, as previously mentioned, there were a total of 110 students enrolled, after 10 students dropped the class in December at the end of the first semester. A total of 106 students completed the ratings as part of the essay assignment. The same 1 to 10 rating scale was used throughout the course and on all the exit tickets; however, on this final one, several students indicated that their interest level was over a 10, and those numbers were included with the data represented in Figure 3. This was because the question asked their current interest rating and students were able to write in the number, rather than indicating it on a scale from 1 to 10.

Figure 3

Final Level of Interest in Forensic Science class from Syllabus by Demographic Subgroup



Note. *N*=106, there were 110 enrolled at end of study period, 106 participants completed the exit ticket rating.

When the interest levels from the beginning of the year, showing the first ratings from the class syllabus, where the mean interest level rating was 6.33, were compared to the ones from the end of the 10-week research period, where the mean score was 7.64, there was an average increase of 1.31 points per participant. This showed that most of the students (72%) indicated that they had a higher level of interest than at the beginning of the year, 27% had no change in interest level and only one participant (1%) indicated that they had a lower interest level from their initial rating on the syllabus at beginning of the school year. These data were identical to the data collected from the qualitative section of the college plan essay that students completed during the last week of the research study where participants were asked to circle one of three responses ("more", "less", or "no change") to the question, "How has your interest level in the class and subject changed?".

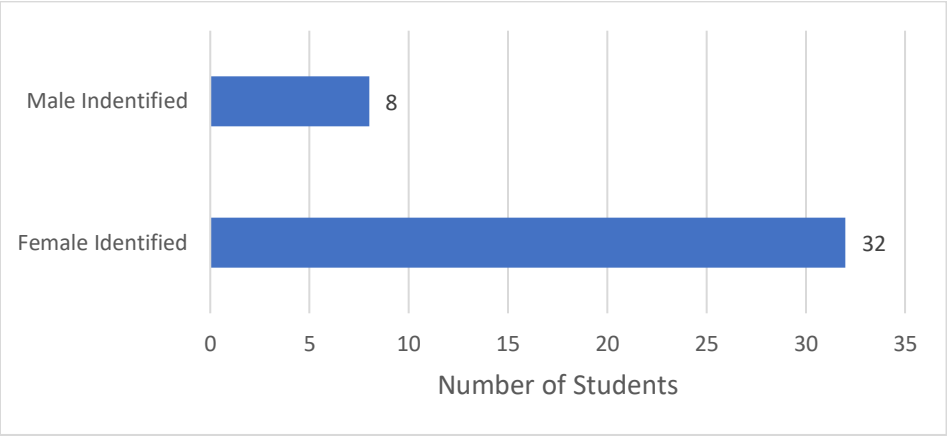
Analysis of Exit Ticket Open-Ended Questions

Throughout the 10-week period, students were asked to respond to open-ended questions on the exit tickets. Most of these questions were focused on identifying activities that students found most helpful during a particular unit, whether they increased their interest levels and or contributed learning experience. One of the open-ended questions that was included on the last exit ticket from the first semester (Appendix C) was, "Name any professional that made an impact on you from any unit covered during the semester." Although only 33% of the participants (N=40) answered this question, 32 female-identified students (80%) recalled an example of a female scientist, while the other 8 responses (20%) were male-identified students that provided the name or description of a female scientist (Figure 4). These results were used to gauge if the inclusion of women and BIPOC STEM professionals had any effect by asking

students to specifically recall one of the featured professionals that had been presented during the semester.

Figure 4

Number of Students that Recalled a Female Scientist by Gender



Note. *N*=40 total students that answered the question.

The qualitative data collected from the exit tickets were used to identify the activities, information or any in-class lesson that contributed to a change in a student's interest level during the unit. Participants were given an exit ticket on day one of semester 2. They were asked to rank the activities that they found most helpful during class. Participant answers were broken down by type of assignment and whether the students found it helpful when learning about forensics. The data indicates that the hands-on activities were named as the factor that increased student interest the most, during all the units from the beginning of the year until the end of the 10-week study period (Table 3).

Table 3

Ranked Activities Indicating Which Assignment Type Increased Interest And/Or Was Most Helpful In Learning About Forensics

	Notes and PowerPoints	Videos (ex. "Forensic Files")	Labs and Other Hands-On Activities	Other Group or Partner Work	Quarter Projects
Total of rankings:	249	241	158	306	407
Total rank of #1:	20	11	55	7	1
% Total #1 rankings	21%	12%	59%	7%	1%

Notes: Rankings (#1 Most helpful to #5 least helpful), N=94 responses, highest score (N=470), lowest score (N=94)

These data reinforce the research that hands-on learning opportunities for students, especially in a science class where they can interact with the materials, increased student interest in the class. Because of the experiential learning activities, student engagement increased, and the interest level of students were affected.

Analysis of Observation Protocol

The observation protocol notes were made during a class activity or investigation on a piece of paper and then immediately transferred onto a Word document at the end of the day, stored in a password protected file on the locked desktop computer in my classroom. This protocol was used at the beginning of the year to collect data on student participation during class, with a focus on the number of female-identified and/or BIPOC students that were identified as the leader that day's activity, for that specific class assignment. It should be noted that these activities or investigations were only included in the data if they took up the entire 90-minute class period or ran over several class periods. There was other work that was completed by table groups that did not require a leader or other roles be assigned, so these were excluded from the observation protocol. These data were collected when students were working in their collaborative table groups where each group was comprised of three to four students. This is a

normal routine in all my classes, and I encouraged every student to take the opportunity to lead their table group in an activity, but it was not a requirement. These quantitative data were collected as I walked around the classroom and checked in with each table group. I asked which student was the group leader and made a tally mark that indicated whether a female-identified or BIPOC student lead the group, or a White male-identified student had been selected. I then totaled these at the end of every forensic class period and next, at the end of the day, recorded this on my computer.

Female-identified and BIPOC students were group leaders for most of the group activities and investigations, with the highest percentage being 97% and the lowest at 73%, which were both the first group activity of the course and the first case that was investigated (Table 4). It should be noted that there was never a time when 100% of the groups had a female-identified or BIPOC group leader.

Table 4

Observation Protocol Tally of Group Leader Demographics by Unit

Unit and Activity # or Investigation Case #^	Number of groups with female-identified or BIPOC leader	Total number of groups in all forensic classes*‡	Percentage of groups with female-identified or BIPOC leader
Investigation Case #1	22	30	73%
Unit 2 – Activity #1	22	30	73%
Unit 3 – Activity #1	23	30	77%
Unit 3 – Activity #2	29	30	97%
Unit 3 – Activity #3	25	28	89%
Unit 3 – Activity #4	26	29	90%
Investigation Case #2	26	29	90%
Unit 4 – Activity #1	27	30	90%
Unit 4 – Activity #2	23	28	82%
Unit 4 – Activity #3	25	29	86%
Unit 4 – Activity #4	22	29	76%
Unit 5 – Activity #1	26	30	87%
Unit 5 – Activity #2	26	28	93%
Unit 6 – Activity #1	26	28	93%
Unit 6 – Activity #2	26	28	93%
Investigation Case #3	24	26	92%
Unit 8 – Activity #1	21	26	81%
Unit 8 – Activity #2	21	25	84%
Investigation Case #4	23	26	88%
Investigation Case #5	24	26	92%

Note. Unit 1 and Unit 7 do not contain any activity or investigation included in this data table.

Note. The maximum number of total groups (N=30) may have been decreased due to absences where students had to be moved into a different group.

Note. After the semester break and the reduction in total students from 120 to 110, the maximum number of groups decreased to (N =26).

The qualitative data were collected after the 10-week study began and were exclusively student responses. These data were coded to be used to investigate the action research question. The responses were separated into two categories after the student groups were asked, “Why is (student name) the leader for this activity?” Responses were separated by “interest” or “other reason.” I collected direct quotes from the student leaders and wrote them down as they were talking (Table 5). Students were informed of this prior to the start of the study and understood that no names or other identifying information would be used.

Table 5

How Student Interest Influenced Students' Choice to Lead an Activity

Example of Student Responses Where "Interest" was Mentioned:	**Example of Student Responses for "Other Reasons":**
"I really like this stuff, it is hella interesting."	"I was the only one here when we took notes."
"I like that this is creative; I like it when forensics and art are involved, this is when I get into this class."	"I was absent last time and I was lost before this so…"
"I did my project on this, I know a lot about it and it's interesting."	"I like that this has math involved, so I thought I should lead the group cuz I'm taking Stats."
"This is like, the first thing that I have liked or wanted to know more about to study in here."	"We're taking turns and it is my turn."
"This is my favorite activity so far. I want to be the leader for all of this blood drop stuff we do outside ."	"I'm kinda the official leader at this table."
"I want to be a fireman and I'm psyched to do an arson lab."	"I didn't want to get that fake blood on me so I'm directing this."
"My plan is to be a cop, so I'm interested in the crime scenes we investigate."	"I don't feel well today, I have a headache so I'm going to sit and do the lab report."
"This is cool, I like it when other kids ask about what we're doing, it makes it more interesting to me."	"I don't really get how to do the math so I'm going to do everything else the leader does."
"I wasn't interested in this topic until we started to do like this hands-on thing, where we get to touch the bones and measure, now I like it."	"I don't think (other student) wants to take his turn so I'm going to be the leader again for this."
"I want to major in Forensics at SJSU, and I want to get like, as much experience, you know, in doing all of this evidence analysis and other crime scene things."	"I can't do the graph so it was that or be the leader."
"I feel like I'm interested when I am in charge of all of the activity and the jobs."	"Honestly, I like to be in charge and when it is a group grade, I want to be the leader."

Note. Names of all participants were excluded from this data.

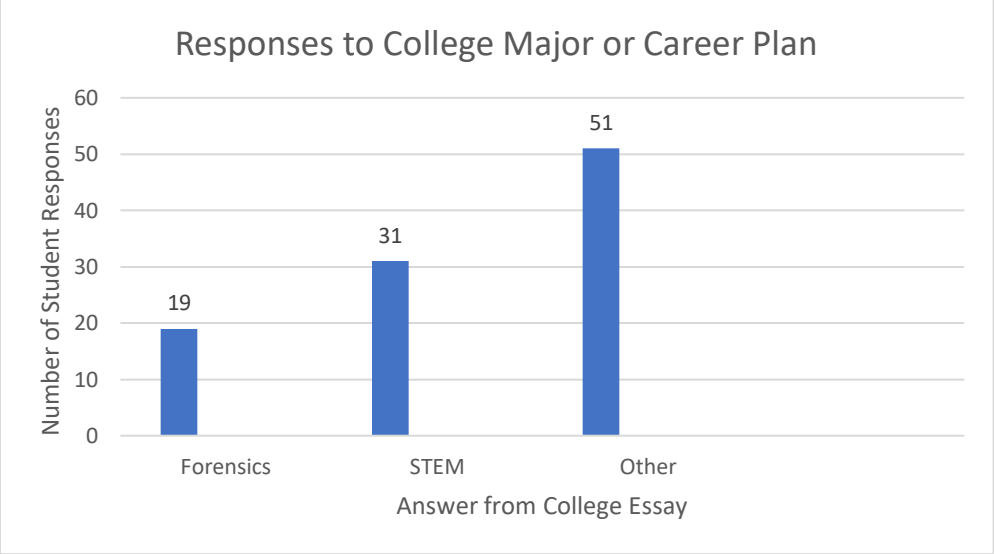
Analysis of College Plan Essay

The college plan essay (Appendix E) was given at the end of the 10-week period during a single class period. Participants were first asked to identify their grade in school, followed by a series of five questions related to their plans after graduating from high school. Participants indicated whether they were planning to attend college, joining the military, getting a job, or

there was an option to write-in another answer. Student responses were separated into three distinct groups before the data was organized and analyzed. The groupings were students planning to pursue a major or career in a forensic science discipline, those students pursuing a STEM degree, and then the rest of the participant responses. Next, the data was further broken down by grade, gender, and race. Of the 19 students that were planning on a future in forensics; 10 were seniors (53%) and 9 were juniors (47%), 16 self-identified as female (84%) and 3 were male-identified (17%), 12 students indicated that their race was BIPOC (63%), and 7 stated that their race was White (37%). Those data are represented in Figure 5.

Figure 5

Tallied responses of participants post-graduation plan



Note. There were 110 students enrolled at the time, but only 101 completed this section of the essay assignment (*N*=101).

Only the essays of the 19 participants who indicated that forensics was their desired major or career were used in the qualitative data analysis from this data source. Those students were asked one additional open-ended question, “Please name one unit, activity, lab, scientist, or any material presented in class up to this point that has had an impact on your *interest level* in the field of forensics. Did it increase or decrease your level of interest in pursuing a career in

forensics?" These students chose to answer the question in the space provided or in their essay. Table 4 includes a response to this question from all 19 participants, as well as their current grade (12th – senior or 11th – junior) in school and self-selected gender (FI – female-identified or MI male-identified) and race (BIPOC or White). Anecdotal data from previous years, where approximately 5% of the students in forensic science stated that they were planning to pursue a career in that field, was consistent before the 2021-2022 school year. Data from this essay assignment suggest that increased student interest affected career plans and college majors.

Table 6

Responses to College Plan Essay of Interest Levels from Participants Planning on a Forensic Career or Major

#	Current Grade	Self-Selected Gender and Race	Response to Interest Level Question
1	12th	FI – White	"Everything about the Fingerprint Unit interested me and made me want to pursue it."
2	11th	FI – BIPOC	"The career research project, I learned a lot about footprint impression analysis and how meticulous and important of a role it can play as evidence"
3	11th	MI – BIPOC	"The psychology unit for sure with anthropology at a close second, it increased my interest."
4	12th	FI – White	"The psychology unit was my favorite unit."
5	11th	FI – BIPOC	"The arson unit has increased my curiosity in forensics specifically how fire interacts with bones."
6	11th	FI – BIPOC	"Increased when studying forensic psychology/pathology, it would be useful when acting as a prosecutor."
7	12th	FI – White	"Crime scenes. I am interested because it is something I really enjoyed, and I didn't feel discouraged after I started to learn about it."
8	11th	FI – BIPOC	"I like the fingerprint lab where we took the fingerprints off the glass. It increased my interest and I thought it was fun."
9	12th	MI – White	"The blood lab was what increased my level of interest because it was really a hands-on lab which I love to do rather than sit in a classroom taking notes."
10	11th	FI – White	"Probably the difference between a psychopath and sociopath assignments. Everything has increased my interests though."
11	12th	FI – BIPOC	"Both the blood unit and the profiling unit really increased my interest in forensics."
12	12th	FI – BIPOC	"The first ever unit we did had a huge impact on me, I learned more about anthropology & rememorized more things than expected. The fingerprint unit was the second best, as well as the blood spatter analysis unit."
13	12th	FI – White	"Serial killer unit and forgery unit. It increased my level of interest a lot."
14	11th	FI – White	"The fingerprint labs increased my level of interest."
15	12th	MI – White	"The criminal profiling and evolution of serial killers was very interesting and increased my interest in forensics."
16	12th	FI – BIPOC	"All of the units positively impacted my interest but if I had to choose one, I'd choose forensic psychology."
17	12th	FI – BIPOC	"The fingerprint labs made me realize that I loke doing this and wouldn't mind a career."
18	11th	FI – BIPOC	"Evidence collecting/blood spatter, it increased the level of interest."
19	11th	FI – BIPOC	"The serial killer unit impacted me more into criminal justice. Reason why is because I got to understand the different of a psychopath and sociopath."

Summary

The purpose of this action research project was to determine what factors may influence female-identified and BIPOC student's interest in a STEM or forensic science major or career and how the specific interventions affected overall student interest in forensic science. The research was conducted over a 10-week period with baseline data gathered at the beginning of the 2021-22 school year. Three data collection strategies were used to explore which interventions embedded throughout the forensic curriculum influenced the participant's level of interest in the class and may have increased the number of students that pursued a STEM or forensic post-secondary program. The data were triangulated from pre, and post unit exit tickets, an observation protocol, and the college plan essay.

The exit tickets were used to collect much of the quantitative data surrounding the students' interest levels but also contained qualitative data that demonstrated how effective the hands-on activities and laboratory investigations were when discussing increases in students' interest and engagement levels. Although the levels of interest varied from unit to unit, with the data being inconsistent, the increases in interest levels from the start of the class to the end of the action research study supports an assertion that there was an overall increase in interest level. Both the observation protocol and the college plan essay contained more data to support how the activities introduced in the classroom affected interest levels of all the participants. The quantitative data from the essay contributed to the finding of an overall increase in student interest levels from the beginning of the study. The data gathered around post-secondary plans further demonstrates an increase in interest from both female-identified and BIPOC students.

Chapter V will continue with an analysis of the data and a discussion of the study results. The researchers that had previously investigated aspects of this action research will be revisited

and a plan for future research will be explored. I will conclude with my reflections on this process and how I will continue to implement changes to further my work as a teacher leader.

Chapter V

Conclusions and Next Steps

There is no doubt that there have been advances made by women regarding equal rights over the past several decades, and most recently with the 2020 election of Kamala Harris, the United States' first female, BIPOC Vice President. But there are still areas where women continue to lag when compared to men. The education research community has determined that the demand for STEM-prepared workers is expected to increase by 75% in the coming years (Griffith, 2010). Research has shown that the STEM field is an example of this inequity, as the United States continues to see a decrease in the number of women enrolling in science and technology majors in college (Gokhale et al., 2015). Data collected through the United States Census Bureau demonstrate that women continue to earn 81 cents for every dollar that men earn (Goldin, 2017). These trends in job growth have exposed the continuing gender gap between men and women that persists today. It is critical for the U.S. labor force to reflect the demographics of its citizens. Educators and counselors must continue to focus on recruitment and retention of both female-identified and BIPOC workers to meet the increasing demand for technologically savvy workers to continue to compete on a global scale.

Over the course of this action research study, my hypothesis focused on the idea that part of the problem was that female-identified and BIPOC students did not see enough examples of professionals in the field that accurately reflected their race, gender, or culture. My hope was to see an increase in the number of female-identified and BIPOC students that were interested in a STEM major when they moved on to college after graduation. I asked the research question*: How will the intentional inclusion of women and BIPOC scientists into the forensic science curriculum increase junior and senior student's interest in a STEM field or major?*

High school is the time where most students begin to chart out their plan for their lives after graduation. Numerous studies have shown that early intervention, where female-identified and BIPOC students are introduced to STEM topics in elementary school, has resulted in an increase in interest levels of students as they progress through middle and high school (Riegle-Crumb & Peng, 2021). Teachers, guidance counselors, administrators, and other stakeholders focused on developing STEM programs have begun to implement more strategies to increase the number of female-identified and BIPOC students enrolling in STEM majors and graduating with a degree in a STEM discipline (Bystydzienski et al., 2015). By focusing on female-identified and BIPOC students, targeted interventions in the form of career counseling or shadowing a professional could help propel these students into STEM fields and disciplines that they may not have considered before they were exposed to the field.

Interest levels of 120 forensic science students, with a focus on both female-identified and BIPOC participants, were investigated over a 10-week period to determine if including examples of working scientists in the field of forensics, accurately reflecting the demographics of the classroom, would lead to an increase in interest and an increase in the number of students who wanted to pursue a job or college major in a STEM discipline. Evidence to answer this research question was gathered from three data collection tools; exit tickets, an observation protocol, and a college plan essay. The data were triangulated and then analyzed in an effort to determine if student levels of interest could be increased by introducing female-identified and BIPOC professionals into the forensic science curriculum.

Summary of Findings

The level of student interest in both the forensic science class and student's post-secondary plans were collected using a mixed-method approach to data collection. Three

different tools were used to gather the findings and measure what, if any, influences the action research had on participants' interest levels and how those levels may have been reflected in the student's career plans and potential college major. Tools were a pre and post unit exit ticket (Appendix B), an observation protocol (Appendix F), and the college plan essay (Appendix E). All 120 students, in the four sections of forensic science participated in the study. However, at the semester break in December 2021, 10 students dropped out of the class (N=110): and only the college plan essays of those students who indicated they were intending to major in a forensic discipline in college (N=19) were included in the data corpus for the study.

Pre-intervention quantitative data were collected from all students enrolled in forensics (N=120) via the class syllabus to obtain a baseline level of interest. This is a frequent practice I employ in all my classes and was included to measure any overall change in interest level from the beginning of the school year to end of the study period. The action research project began after IRB approval was obtained and ran over a 10-week period. During the intervention phase, I collected both qualitative and quantitative data from the students at the beginning of each unit, as they completed group work during units, at the end of each unit and then at the end of the study. The study concluded with the college plan essay with 92% of the participants (N=101) completing the assignment. All the data collected was stored either in a password protected file on my locked desktop computer, or in a binder that was kept in a locked drawer in my desk.

Exit Ticket Ratings

The initial interest ratings from the course syllabus showed a mean interest level of 6.33 (N=120). Post study, the mean interest level increased to an average score of 7.64 (N=101). This showed an overall increase in interest level of 17%, with an average increase in interest of 1.31 points from the beginning of the course to the end of the action research study period. The

change in total number of students was because the syllabus was a requirement and graded, so all the 120 students enrolled in the course completed it: and at the semester break in December, 10 students dropped out of one of the four forensic classes. The syllabus was the only rating that had a grade for the course associated with it. All the other exit ticket ratings were obtained from the participants voluntarily. At the end of the 10-week research period, 101 students completed the college plan essay, where the final interest levels were gathered. Overall, the quantitative data from these ratings showed that 72% of the students reported an increase in their interest levels, compared to a single student who indicated a decrease in interest and the remaining 27% noted that there was no change in their overall interest level.

Research strongly suggests that offering students more opportunities to engage with curriculum that includes hands-on laboratory investigations increased students' test scores, their acquisition of science skills, and their attitudes towards science classes (Markowitz, 2004). The inquiry-based activities and practice-oriented crime scenes that were offered to the participants of this action research study were rated as the most the most effective tool in increasing interest levels in forensic science (Table 3).

Exit Ticket Open-ended Questions

The majority of the open-ended questions on the exit tickets centered around student opinions on how they best learned and how the content was presented to them. Students were asked to identify which activities either increased their interest or most contributed to their learning during a particular unit. The results of the analysis of these questions suggest that the hands-on, experiential learning activities exclusively were the deciding factor of what increased student interest levels. Approximately 60% of the participants ranking them as number one, on a scale of 1 to 5, with 1 representing the most impactful activity and 5 being the least (Table 3).

The other activities, in order of most to least interest were the notes and PowerPoint slides, in-class videos, other group or partner work, and then the two quarter projects. The slides were shown in class as the introductory activity when beginning a new unit. The women and BIPOC STEM or forensic professionals were a part of these presentations. The combined percentage of the #1 and #2 activities the most affected student interest and learning totaled 80%, suggesting that the inclusion of both BIPOC and women STEM professionals, in addition to the opportunity to interact with the curriculum during hands-on laboratory investigations increased student interest in a STEM major or career.

The research question explored how intentional exposure to scientists and professionals that accurately reflected the demographics of the classroom, influenced how female-identified and BIPOC students potentially saw themselves pursuing a STEM major or career. This, when partnered with hands-on learning activities, allowed both groups of students to bridge these two ideas. Part of the issue with the lack of representation of female-identified and BIPOC role models is the inability of science programs to offer students the opportunity to have hands-on experiences with the course content (Riegle-Crumb & Peng, 2021). By introducing women and BIPOC professionals as the actual researchers and the examples of scientists who are conducting these experiments, the results suggests that the participants were be able to make connections to the curriculum.

The research conducted by John Dewey (1998) demonstrated that the benefits of experiential learning were that students could immediately apply the knowledge to real-world problems and applications, suggesting an increase in both achievement and student engagement. When students worked collaboratively in teams, it allowed them the opportunity to develop communication, collaboration, and negotiation skills. The benefit of investigations involving

hands-on experiments or activities to provide students with opportunities to practice skills needed for a future in a STEM field or career (Kolb, 2015).

Observation Protocol

Both quantitative and qualitative data were collected using the observation protocol. The quantitative data collected was totaled and the number of female-identified and BIPOC students who volunteered to lead their table group during an activity was recorded (Table 4). This is part of my regular practice in all my classes; and although all students are encouraged to lead at least one activity, there is no requirement to do so. The data indicate that there were always both BIPOC and female-identified group leaders during collaborative work. The lowest percentage was at the beginning of the course when 73% female-identified and/or BIPOC students were chosen or chose to be group leaders (Table 4). This is consistent with prior year's anecdotal data where more male-identified students tend to volunteer during the first one or two group activities versus female-identified students. The highest participation rate was 97% during Unit 3. On average, 86% of groups during the 20 activities where the observation protocol was used, had a female-identified or BIPOC student as a leader.

The qualitative data that were collected from the students directly, showed the reasons why a particular student functioned as group leader during the class activity. Student responses were divided into two categories; those responses that mentioned interest as a factor and answers that did not (Table 4). These findings corroborate those of Gokhale et al. (2015) study which concluded that there was a correlation between the amount of experience students had in school with opportunities to engage in science and technology practices and the level of interest and how much they liked these content areas.

College Plan Essay

All participants were given a college plan essay during the last week of the 10-week action research period: and 101 students completed it, which is 92% of the 110 students enrolled in the four forensic classes at the time. The analysis of the responses showed that 19% of the students indicated they planned on a major or career in forensics; and an additional 31% said they were intending to study another STEM discipline. These two groups together was 50% of the responses planning on pursuing either a forensic or STEM major after their high school graduation. Of the 19 students who were planning on a future career in forensics; 10 were seniors (53%) and nine were juniors (47%), 16 self-identified as female (84%) and three were male-identified (17%), 12 students indicated that their race was BIPOC (63%), and seven stated that their race was White (37%).

The remaining quantitative data collected from the essay indicated that 72% of participants stated they were more interested at the end of the study in the forensic class than at the beginning. The breakdown of the remaining participants' interest levels were as follows: 1% was less interested and 27% indicated that there was no change in their overall interest level.

Interpretation of Findings

Based on the analysis of the quantitative and qualitative data collected from the three tools used during the 10-week action research study, I was able to draw the following conclusions: student interest level was most influenced by the hands-on, experiential learning activities embedded in each individual unit, data showed an overall increase in interest level from all students, and more students planned to pursue either forensics or STEM majors as shown by their responses around their post-secondary plans.

Increase in Interest

The overall interest levels in post-secondary career plans of students increased by providing them with culturally relevant examples of working STEM professionals, as well as the opportunity to work with the forensic materials during hands-on investigations and activities. The importance of increasing student interest and its connection to student engagement is critical (Gay, 2002b). Both female-identified and BIPOC students have traditionally lacked the science preparation of their White male peers (Gokhale et al., 2015). In the field of social science, research has supported the idea that stereotypes around gendered beliefs of math ability by male and female students have played a role in the system of gender inequity in education (Riegle-Crumb & Peng, 2021). Geneva Gay's (2002b) culturally responsive teaching (CRT) theory discussed the need for teachers to become more aware of the demographics of their classes and how to bring a wider lens that included different cultures, races, and ethnicities into the forefront of their pedagogy. This action research study embedded examples of both women and BIPOC professionals in STEM fields into the introductory lessons of each unit to introduce students to relevant and relatable examples of actual STEM examples with whom they might identify with. The results suggest that the participants began to visualize themselves as STEM workers: and as a result, the overall interest level of the participants increased. The link to student interest can also be expressed by increased achievement and engagement. Many elementary education practitioners suggest that early intervention and introduction to science may be one factor that increases student interest (Gokhale et al., 2015).

Bystydzienski and colleagues (2015) conducted a study over a three-year period with high-achieving, female sophomore students in high school. The researchers concluded that when the participants were provided with a deliberate introduction to an engineering curriculum and

learned about engineering careers, it resulted in an increase in student interest in the field of engineering when considering potential college majors. This study reinforces the advice of experts in education that STEM education needs to start in middle or even better in elementary school (Bystydzienski et al., 2015).

More STEM College Plans

I was able to influence student views on careers in forensics and STEM disciplines by consistently providing examples to the female-identified and BIPOC study participants that accurately reflected their gender, race, and ethnicities. When female-identified and BIPOC students were introduced to role models early on in their education and were given opportunities to work on project-based laboratory investigations in elementary and middle-school, the research suggests that are more likely to imagine themselves as scientists when they graduate from high school (Gokhale et al., 2015). The analysis of the college plan essay suggests when student interest is piqued, they are engaged in learning: and when they see themselves represented in the curriculum, there is a corresponding increase in the numbers who planned to enroll in STEM majors by both female-identified and BIPOC students. Much research presented previously has demonstrated that both women and BIPOC students benefit from targeted support from mentors and peers alike.

Tai et al. (2006) conducted a longitudinal study that asked eighth grade students their future career plans when they were 30 years old. This study concluded by following up with the participants that had obtained a baccalaureate degree. The researchers were able to show that when the students in middle school indicated that they were planning to pursue a career in science, they were almost twice as likely to have graduated with a four-year degree from a college science program. The researchers suggest that exposing students to science – based

careers in eighth grade or earlier, may have a causal effect on their choice of college major (Tai et al., 2006). The researchers concluded that the students who showed an early interest in a science career were more likely to graduate from college with a STEM degree, showing a possible link between early encouragement and exposure to science and a career in science.

Morganson and colleagues (2010) researched the data showing a persistent lack of representation of women in STEM majors and careers and how the number of women enrolled in these majors and present in the work force has continued to decline. One of the important conclusions from this research is the importance of peer support for underrepresented populations and the use of mentors to support these students (Morganson et al., 2010). The mentor is often the same race, gender, or ethnicity so that students can see a role model that is like themselves. Once again, the research by Gokhale and colleagues (2015) highlights the issue that women and BIPOC students continue to be underrepresented in STEM majors in college and in these careers as they join the workforce. The researchers also concluded that women drop out of STEM majors, even when they are highly-qualified students, at a higher rate than their male cohorts (Gokhale et al., 2015).

Reflection of Limitations

This action research project was conducted over a 10-week period using eight of the units taught in a year-long forensic science course that traditionally consists of approximately 15 units, so time is one of the constraints affecting the results. It is possible that one of the later units, not examined during the study, could have affected the overall interest ratings differently than those from the beginning of the school year and the end of Unit 8. Conversely, one of the earlier units could have been affected by students "over-rating" their interest in the forensic class because the teacher was asking them.

Another factor that may have affected the results was that all the participants were juniors and seniors in high school, so they may have already made up their minds about their post-secondary plans before enrolling in the forensic class, and it affected their answers on the college plan essay. Even though all the students enrolled in forensic science participated in this project, they represent approximately 10% of the total number of juniors and seniors enrolled at the school site at the time this action research was conducted. There could possibly have been other senior students that had the intention of pursuing a forensic major but were unable to enroll in the class due to a scheduling conflict or another issue. A longitudinal study that tracked interest levels of first-year students, continuing throughout all their science classes from 9th to 12th grade would provide more accurate data on interest in a potential STEM career or major, as well as provide teachers with more opportunities for earlier interventions.

Based on the last six years of teaching forensics, my understanding of the numbers of students pursuing a post-secondary degree in Forensics was based on anecdotal information. Although I did ask all those students their future plans, and wrote college recommendations for most of them, I did not collect quantitative data, but used class time to ask questions and supported my claim with the number of students who were accepted into these college programs and informed me of their plans.

In addition, I was both the teacher in the class and the researcher on this study. This could have affected student interest levels by artificially inflating or deflating them. Moreover, the responses to the college plan essay may have been influenced by my role as well. The high school where this action research study took place, geographically and demographically, may not accurately reflect other California high schools and the results may not be comparable in those cases.

Summary

The results from this action research study offer educators some insight as to their roles in increasing student interest in the STEM field, particularly targeting female-identified and BIPOC students. The use of experiential learning in science classrooms suggest that these types of activities increase interest levels and possibly the post-secondary plans of both female-identified and BIPOC students. By using the examples of working professionals that accurately reflected the participants in this study, the overall mean interest levels in a post-secondary STEM or forensics science career increased.

Plan for Future Action

Over the course of this action research project, I wanted to see how the inclusion of both female-identified and BIPOC working STEM professionals affected my students' overall interest in pursuing a STEM major or career after graduation from high school. The results of my study have increased my understanding of how experiential learning activities can have a positive impact on students' interest levels. The knowledge I gained through this study will assist me as I continue to modify the forensic science curriculum and continue to use hands-on, real-world investigations and activities as a tool to increase student interest in STEM fields. The importance of using examples of working professionals that reflect the diverse demographics in my classes will guide my planning as I work to include more STEM scientists who are both BIPOC and/or female-identified. One adjustment to my grading that I will implement next year will be to require all the students to complete both the pre and post ratings at the beginning and end of every unit. This information allows me to continually reflect on my practice and update the content being delivered to the students, based on their levels of interest. This type of student

feedback is quite valuable, as I work to continue to encourage all interested students to pursue STEM careers after high school.

The results from this action research project and other studies previously mentioned in Chapter II (Bystydzienski et al., 2015, Gokhale et al,, 2015, Tai et al., 2006), suggest that early intervention, in both elementary and middle school, can possibly influence the interest levels of students in all the STEM disciplines. Despite what I found during conducting this research, there may be a limit to student interest and the influence it has on potential STEM majors and careers. A recent study has reported that junior and senior female students in high school have more aptitude than interest in the STEM disciplines (Kuykendall, 2022). The researcher used information gathered from female junior and seniors that completed aptitude assessments. This is a concerning statistic as the U.S. Bureau of Labor Statistics "predicts STEM jobs will grow by at least 8% annually through 2029, as the number of non-STEM jobs grows at less than half that pace" (Kuykendall, 2022). My research may offer a way to overcome this discrepancy between aptitude and interest. With the continued need for highly-qualified, STEM prepared workers, both female-identified and BIPOC students will be necessary to fill the gaps in the STEM field and help the United States maintain the number of scientists, technology workers, engineers, and mathematicians needed to move our country forward.

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Appendices

Appendix A

Please sign and return to class – this is the first grade in the gradebook.

Student's name (print): _____ Period: _____

Preferred name to be used: _____ Pronouns: _____

Student's signature*: _____

Parent/guardian email: _____ Phone # _____

Parent/guardian signature*: _____

**By signing this syllabus, I agree to adhere to and support the policies in the Forensics class.*
From the "Annual Notice to Parents and Guardians" (page 7):
"You must send a note and/or phone the school within 72 hours to clear any excusable absence.

Assignment #1:
Question A:
This syllabus states that a student's grade will be, in part, dependent on their attendance in this class. Please write on the lines below what you believe this means. How does your attendance impact your grade in this class?

_____

_____

_____

Question B:
The field of Forensic science has a tremendous number of jobs and potential college majors. On a scale from 1 to 10 (1 being "not interested" and 10 being "this is my major") please rate where you are right now, when considering this class and this field as juniors and seniors in high school. *Please circle your selection below.*

1 2 3 4 5 6 7 8 9 10

WHY did you choose this number? (1 sentence here please!)

_____

_____

Appendix B

Pre and Post Unit Exit Ticket

a. We are starting the _____ unit. What do you think you will be learning about?

b. Rate this unit on a scale of 1 – 10 on your interest BEFORE we begin this unit. _____
Please provide one reason why you chose this number.

c. When thinking about the *previous* unit and comparing it to this upcoming unit, please circle the phrase below that BEST describes your approach to the _____ unit.

1. I am more interested. 2. I have the same level of interest. 3. I am less interested.

****

Date: _____

a. What was the lab or activity that you learned the most from during this unit?

the least?

b. Rate this unit on a scale of 1 – 10 on your interest after this unit, compared to your interest rating at the beginning of the unit? _____

c. What changed your rating? (Be specific: an activity, lab etc.?)

d. Do you have any interest in pursuing this specialty as a career? Why or why not?

THANK YOU for your input!

Appendix C

End of Semester 1 – Ratings

1. Please RATE the UNITS covered in Forensics: #1 is your favorite, to #6 – least interested.

_____ Intro to Forensics
_____ Crime Scene and Evidence
_____ Anthropology
_____ Blood
_____ Fingerprints
_____ Arson

2. Which activities do YOU believe are the MOST helpful in learning about Forensics?

3. Of the units covered during semester 1, if you had to choose a career from those disciplines, which one would you choose?

_____ _____

4. Do you recall ANY example of a Forensic scientists (you don't have to know their name) presented during the semester? Please provide any information about them.

5. After completing a semester of Forensics: (Please CIRCLE your response.)

I am MORE interested in pursuing this as a potential career/major.

My interest level in a Forensic career/major has remained the same.

I am LESS interested in pursuing this as a potential career/major.

THANK YOU FOR ALL OF YOUR HARD WORK DURING THE SEMESTER. HAPPY HOLIDAYS!

Appendix D

Beginning of Semester 2 – Ratings

1. Please RATE the UNITS that will be covered in Forensics during Semester 2:
   (#1 is most interested, to #7 – least interested)

_____ Psychology and Behavior
_____ Body Language and Clues to Reading People
_____ Toxicology
_____ Autopsy & Cause of Death
_____ Handwriting Analysis & Document Analysis
_____ Entomology (Insects to Determine Time Death)
_____ Deductive Reasoning Labs & Logic Puzzles

2. Which activities do YOU believe are the MOST helpful in learning about Forensics?
   (#1 – MOST helpful - #5 least helpful)

_____ Notes and PowerPoints
_____ Videos (Forensic Files)
_____ Labs and other hands-on activities
_____ Group or partner work
_____ Quarter Projects

Please circle either AGREE or DISAGREE after reading each statement.
<u>This is YOUR opinion only</u>.

AGREE	DISAGREE	Boys and girls at this school have equal opportunities to take elective classes.
AGREE	DISAGREE	The gender and/or race of the scientist (example) shown in class is important to me.
AGREE	DISAGREE	I would feel comfortable being the only one of my gender in a college class.
AGREE	DISAGREE	The teacher or the professor has an effect on how well I do in class.
AGREE	DISAGREE	The teacher or the professor being the same race or gender as me is important.
AGREE	DISAGREE	I would feel comfortable calling out a classmate that I saw being disrespectful to another student.
AGREE	DISAGREE	Classes that have opportunities to work with the materials and do hands-on activities are easier than ones where these lessons are not used.

THANK YOU for answering these questions and **WELCOME BACK** to **FORENSICS!**

Appendix E

College Plan Essay

Directions: Read the questions below and either fill-in or CIRCLE your answer. The essay needs to be one paragraph *at a minimum.* Please include all the information requested. THANK YOU!
Important: Answer as if you have no obstacles preventing you from attending the college or university of your choice and pursing the major that you are most interested in.

1. I am currently a _____. (CIRCLE YOUR CHOICE) **JUNIOR** **SENIOR**

2. Are you planning on attending a 4-year college/university or a 2-year junior college after graduation? (CIRCLE YOUR CHOICE) **YES** **NO** If you answered YES, skip to question #4.

3. If you answered NO, what are your plans? (CIRCLE YOUR CHOICE) THEN PROCEED TO #9.
JOB **JOIN MILITARY** **TRADE/ VOCATIONAL SCHOOL** **OTHER**: _____

4. If you answered YES, what is your *PLANNED MAJOR OR FIELD OF INTEREST?* _____

5. Is your planned major or field of interest in a STEM category? (Science, Technology, Engineering and Math) (CIRCLE YOUR CHOICE) **YES** **NO**
If you answered NO, proceed to # 9, #10, and then the essay.

6. If you answered YES, it is in the field of FORENSIC SCIENCE or one of the related disciplines? **YES** **NO** If you answered NO, proceed to #9, #10, and then the essay.

7. If you answered YES, please explain *exactly* what you are interested in pursuing in the field of forensics?_____
_____

8. What is the #1 issue or concern that may prevent you from pursing your career/major/goal?
_____
_____

9. Please name one unit, activity, lab, scientist, or any material presented in class up to this point that has had an impact on your *interest level* in the field of forensics. Please be specific. Did it increase or decrease your level of interest in pursuing a career in STEM or forensics?
_____
_____

10. LAST QUESTION: Thinking back to the beginning of the year, how has your interest level in the class and subject changed? I am _____ interested in this subject/class? (CIRCLE YOUR CHOICE)

MORE **LESS** **NO CHANGE** **1-10 scale: _____**

Appendix F

Observation Protocol

Date	Unit # and Activity	FI or BIPOC Lead count:	Total Group #	Q: Why are you the leader today?
				A: